Hagenson, I.

A Fisheries Inventory of Morfee, Ewart, Lynx and Carr-Harris lakes, 1979.

MANITOBA
DEPARTMENT OF NATURAL RESOURCES
Fisheries Branch

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1983

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ABSTRACT

This inventory was conducted from August 2, 1979 to August 15, 1979 to determine the sport fish potential of Morfee, Ewart, Lynx and Carr-Harris lakes and to permit the development of an allocation and use strategy for these recreational fisheries. Morfee, Ewart, Lynx and Carr-Harris lakes are mesotrophic, headwater lakes on the Precambrian Shield and as such are low in productive capacity. They have a small standing crop of fish and are probably at their climax capacity.

The limited angling potential offered by the walleye and northern pike populations of these lakes make them unattractive as lodge lakes. The number of beds required to be economically viable would stress the limited base of the fish resource and lead to overexploitation. However, outcamp facilities of the following numbers of beds would be considered for these lakes:

Morfee	6 beds
Ewart	6 beds
Lynx	5 beds
Carr-Harris	14 beds

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INTRODUCTION

Morfee, Ewart, Lynx and Carr-Harris lakes are presently accessible only by aircraft or canoe. The relative isolation of these lakes will eventually change as an expanding transportation network penetrates further into the area east of Lake Winnipeg.

The remote nature of the lakes on the east side of Lake Winnipeg ensures relatively light angling pressure. The results of the angling licence questionnaire in 1972 indicated 167,547 angling days spent in the East central portion of Manitoba. The 1981 angler survey indicated 216,172 angling days were spent in the same area. This is an increase of 22.5% in nine years. Most of the angling days were exerted by guests of lodges in the East Central area.

Two trappers' cabins, one on Ewart Lake and one on Carr-Harris lake, are the only permanent structures on these lakes. There are no permanent structures of any kind on Morfee and Lynx lakes.

This study was conducted from August 2, 1979 to August 15, 1979. The objectives of this study were to determine the sport fish potential of the lakes and provide baseline data to permit the development of an allocation and use strategy for the recreational fisheries.

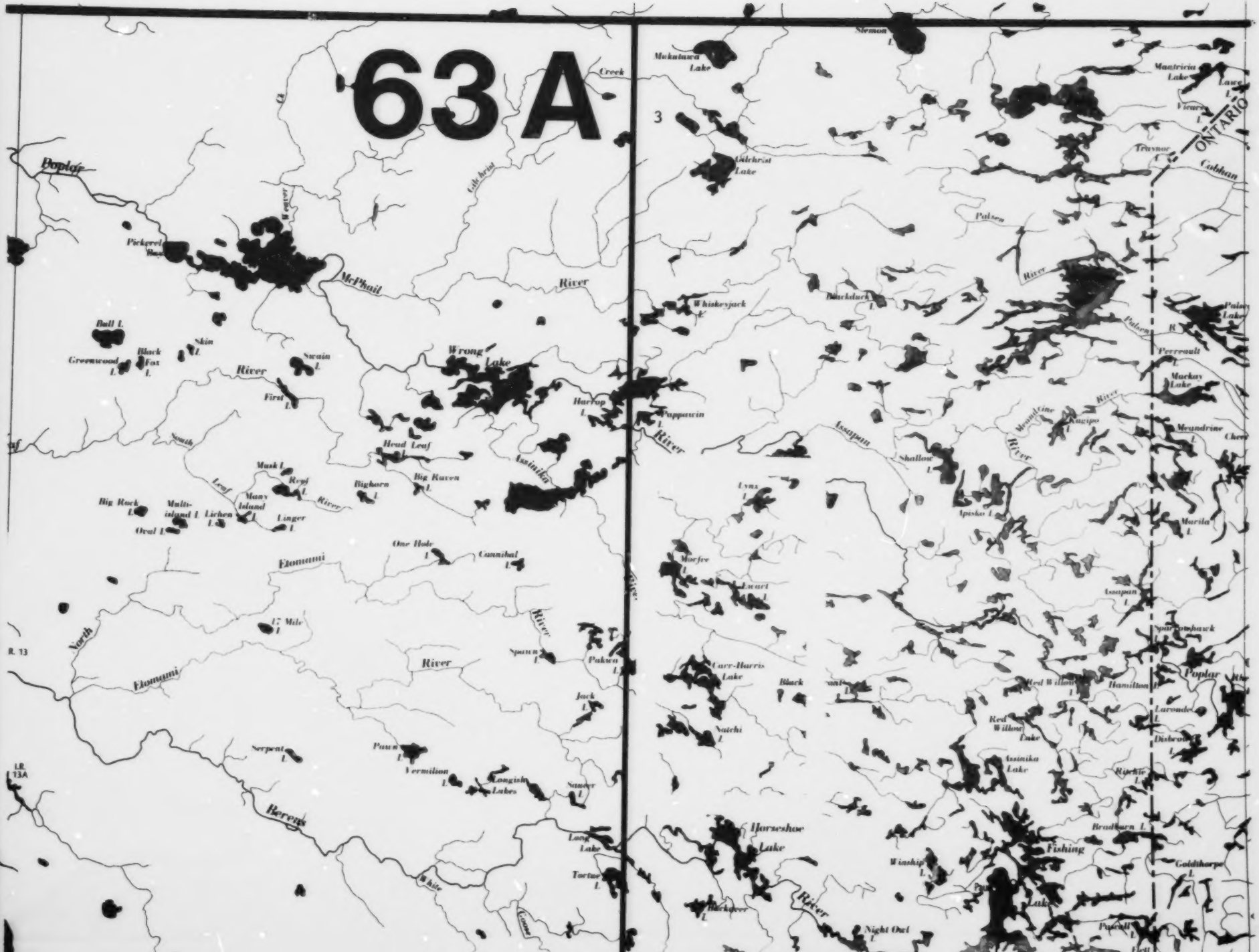
The Study Area

Morfee, Ewart, Lynx and Carr-Harris lakes are located approximately 290 kilometres northeast of Winnipeg (Fig. 1). Their exact locations by latitude (N) and longitude (W) are as follows:

Morfee	52° 28' 95° 56'
Ewart	52° 26' 95° 49'
Lynx	52° 32' 95° 47'
Carr-Harris	52° 21' 95° 53'

All of the lakes are located on the Precambrian Shield. The topography of the area is Precambrian drift plain of a rolling to hilly nature. The surface deposits consist of varying amounts and thicknesses of glacial drift with abundant rock outcrop. Bogs and lakes cover 40 to 60 percent of the surface (Weir 1960). A more complete description of the geology and soil composition of the area may be obtained from Dutchak et al. (1978).

The natural vegetation of the area is northern coniferous forest consisting mainly of black spruce (Picea mariana) and white spruce (Abies balsamea). There is jackpine (Pinus banksiana), white birch (Betula papyrifera) and balsam poplar (Populus balsamifera) in areas of recent burns (Weir 1960). A detailed mapping of the vegetation surrounding each lake may be obtained from the Forest Inventory section of the Department of Natural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White
Creek
Gilchrist
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Manitricia Lake
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Travnor
Gobban
Palsen
Whiskeyjack
Blackduck
Perreault
Mackay Lake
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Assapan
Shallow
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Apisko
Marila
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Ewart
Carr-Harris Lake
Natchi
Red Willow
Hamilton
Larondee
Dishrag
Asinika Lake
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Bradburn
Goldthorpe
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Night Owl
Pipestone
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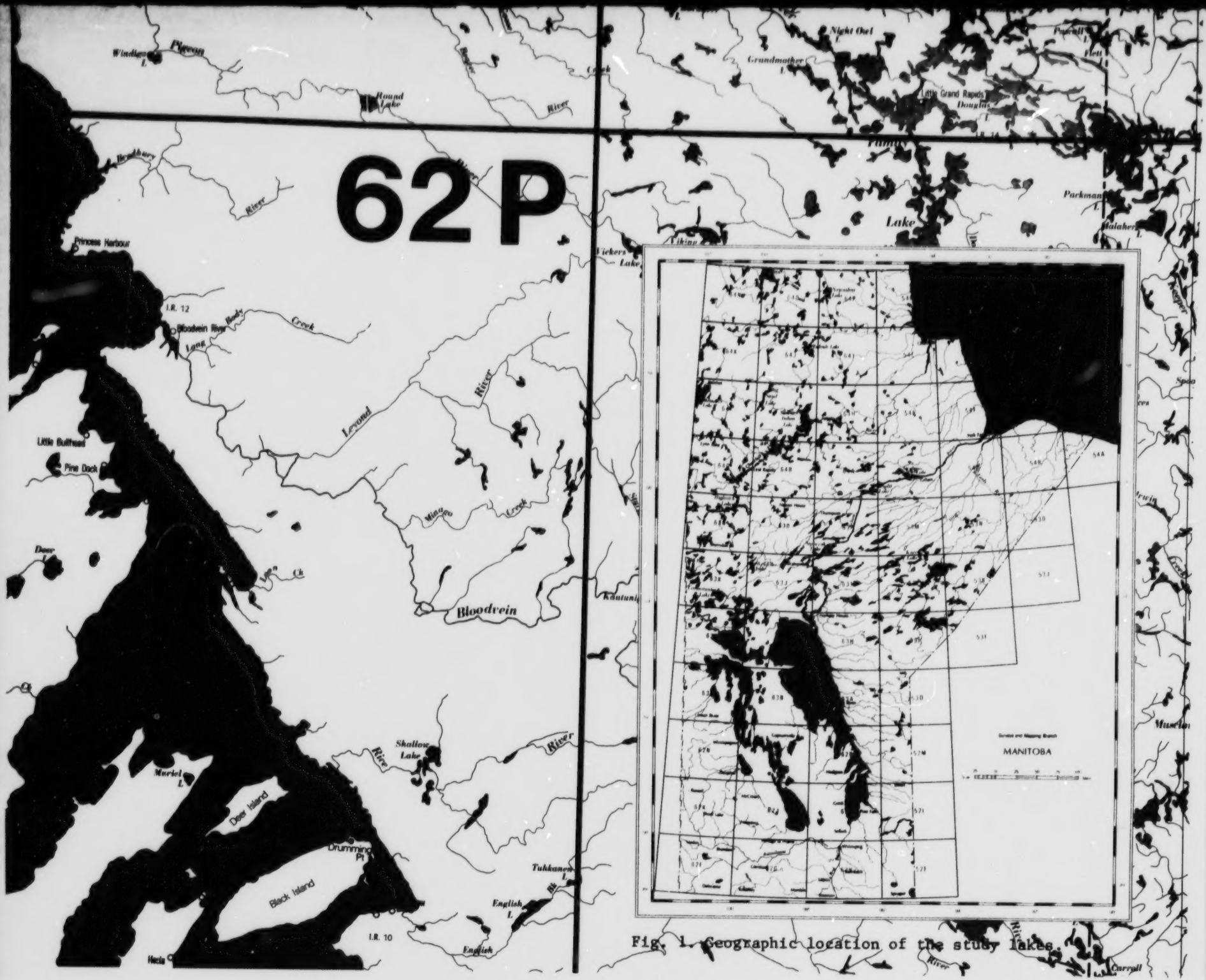

Fig. 1. Geographic location of the study lakes.

Resources.

The principal species of emergent vegetation in these lakes were cattail (Typha sp), floating leaf pondweed (Potamogeton natens), yellow water-lily (Nuphar variegatum), bulrush (Scirpus sp) and wild rice (Zizania aquatica).

Morfee, Ewart and Lynx lakes are headwater lakes of the Poplar River, and have a drainage basin area of 290 km^2. Morfee Lake has only one inflow which enters the west bay and drains an outlying lake (Fig. 2). Ewart Lake has only one inflow which drains a muskeg and bog area at the east end of the lake (Fig. 3). Lynx Lake has two small inflows at the south east end of the lake. These drain a small outlying lake and muskeg and bog areas (Fig. 4).

Carr-Harris is a headwater lake of the Assinika River and has a drainage basin of 192 km^2. The principal inflow of Carr-Harris Lake enters the south east bay of the lake. There are two other small inflows, one in the southeast bay, the other at the extreme west bay which drains a small outlying lake and bog area. The only outflow drains to the Assinika River (Fig. 5).

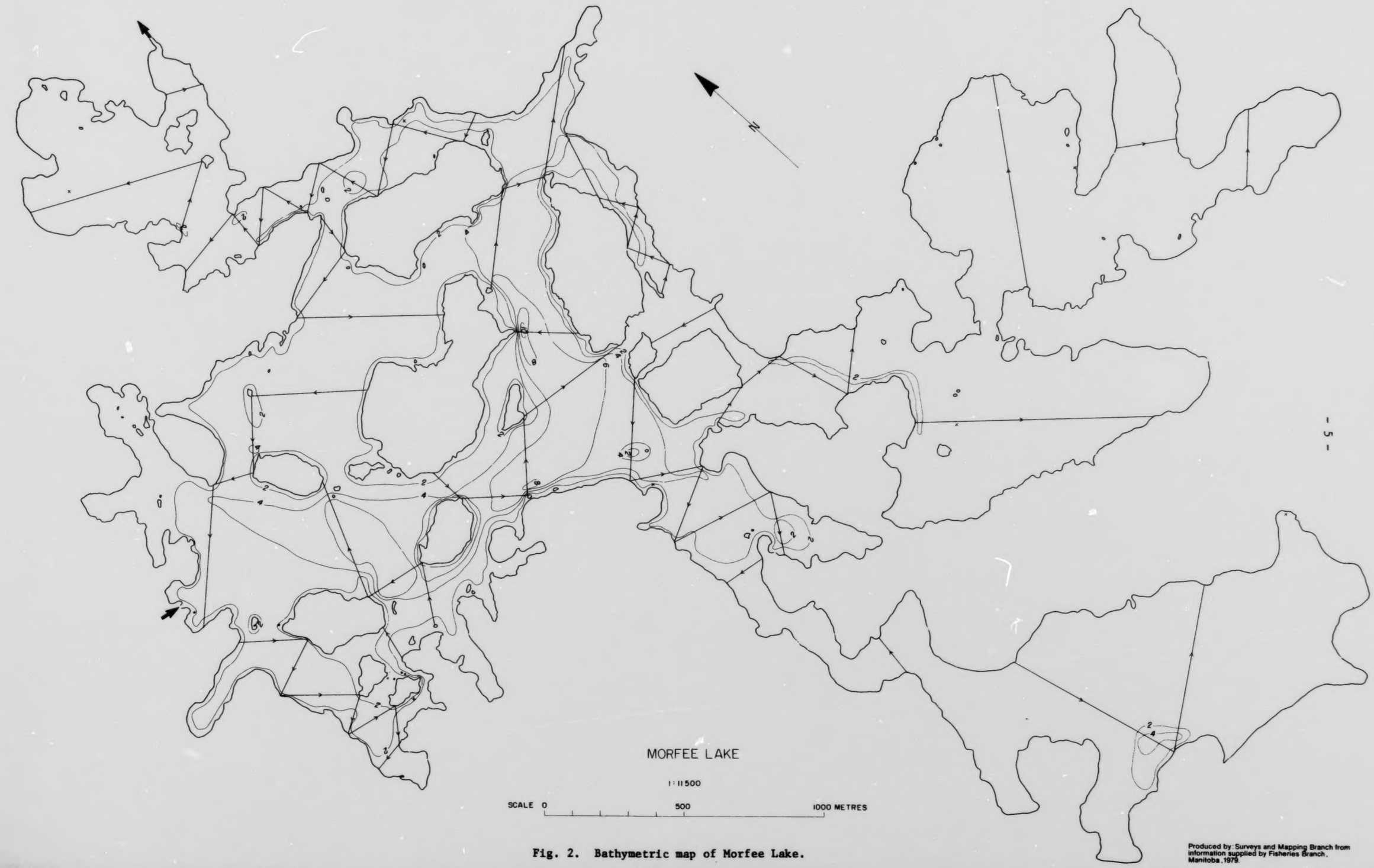

Fig. 2. Bathymetric map of Morfee Lake.

Produced by Surveys and Mapping Branch from information supplied by Fisheries Branch, Manitoba, 1979.

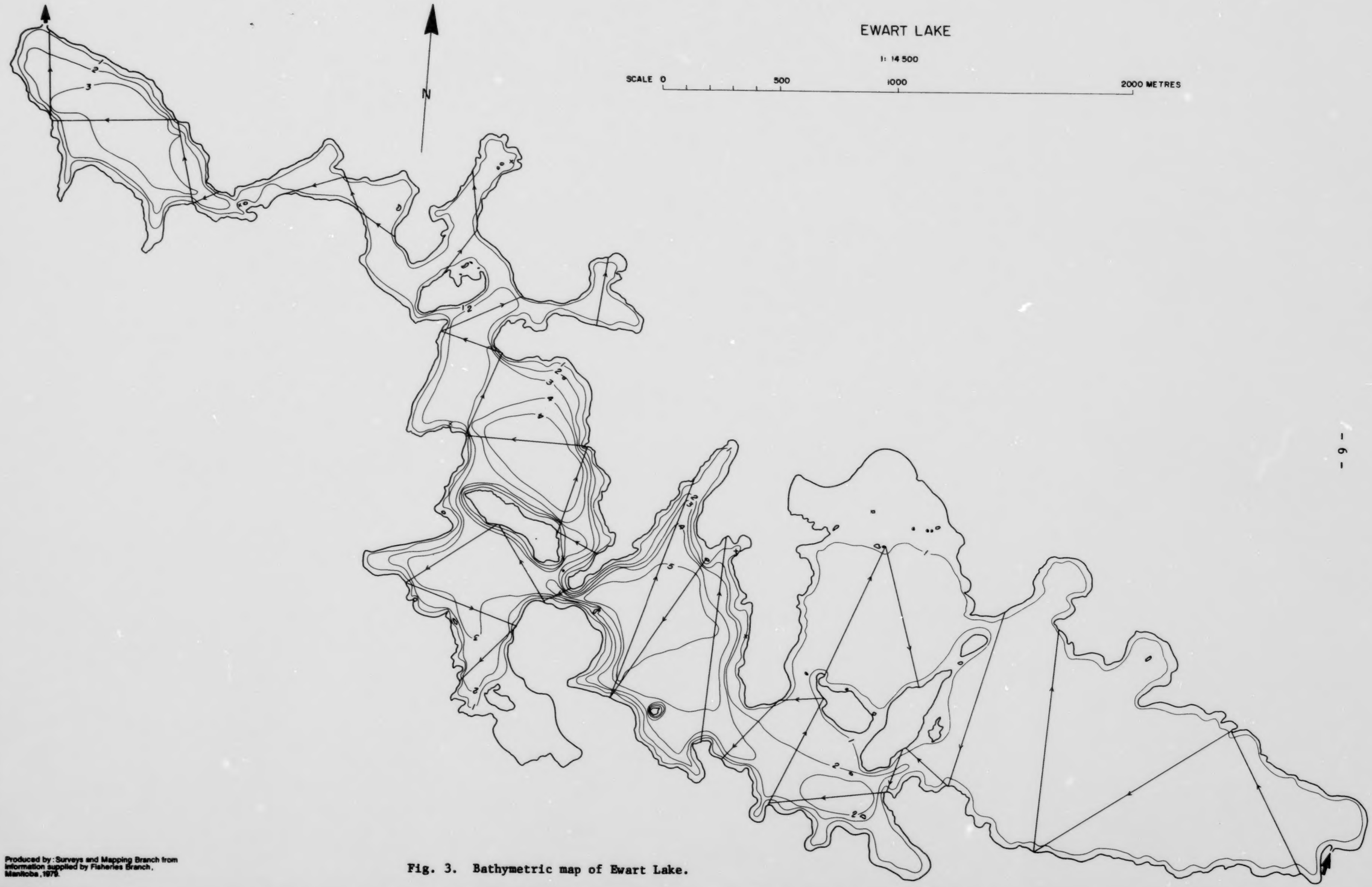

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Fig. 3. Bathymetric map of Ewart Lake.

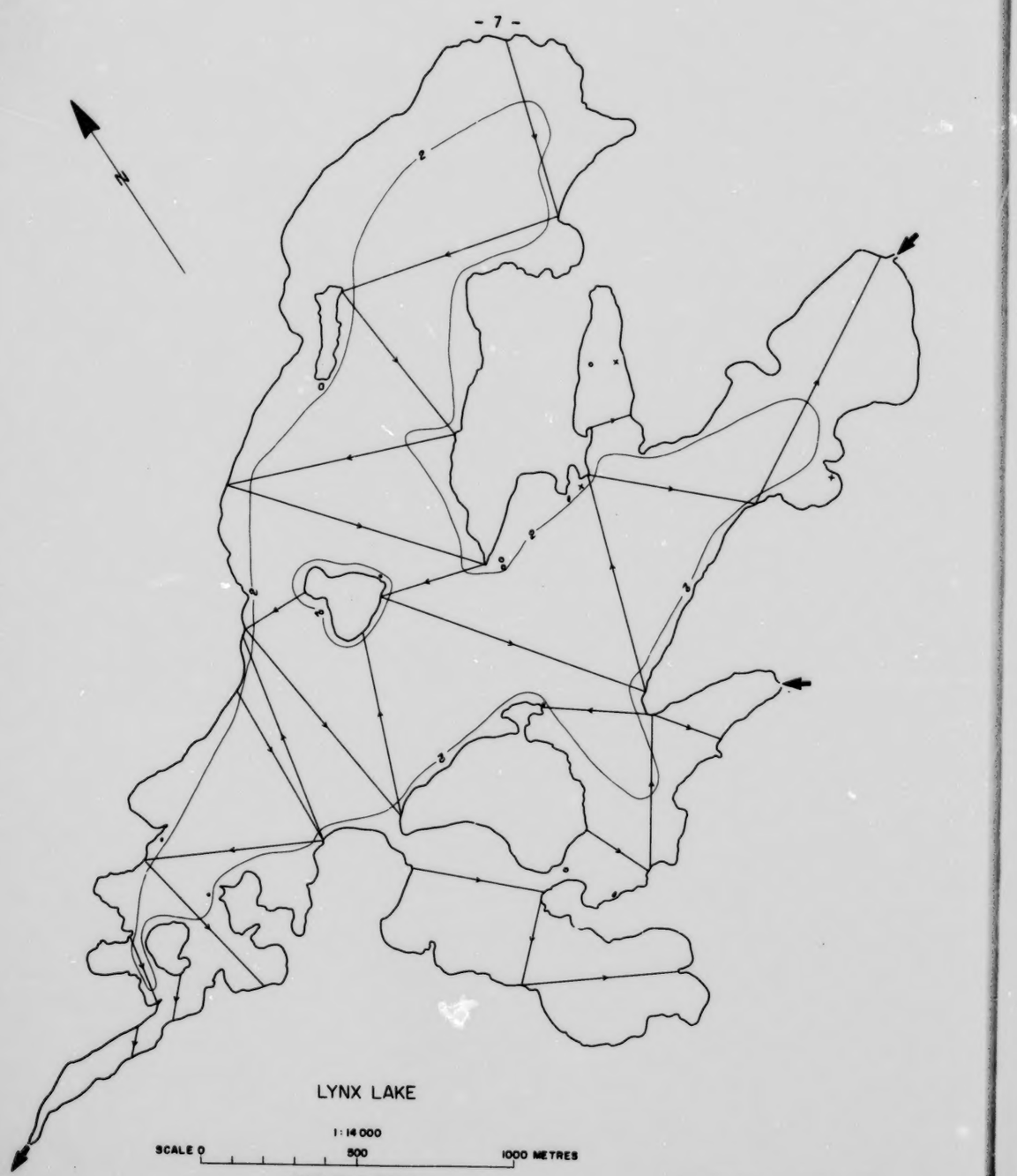
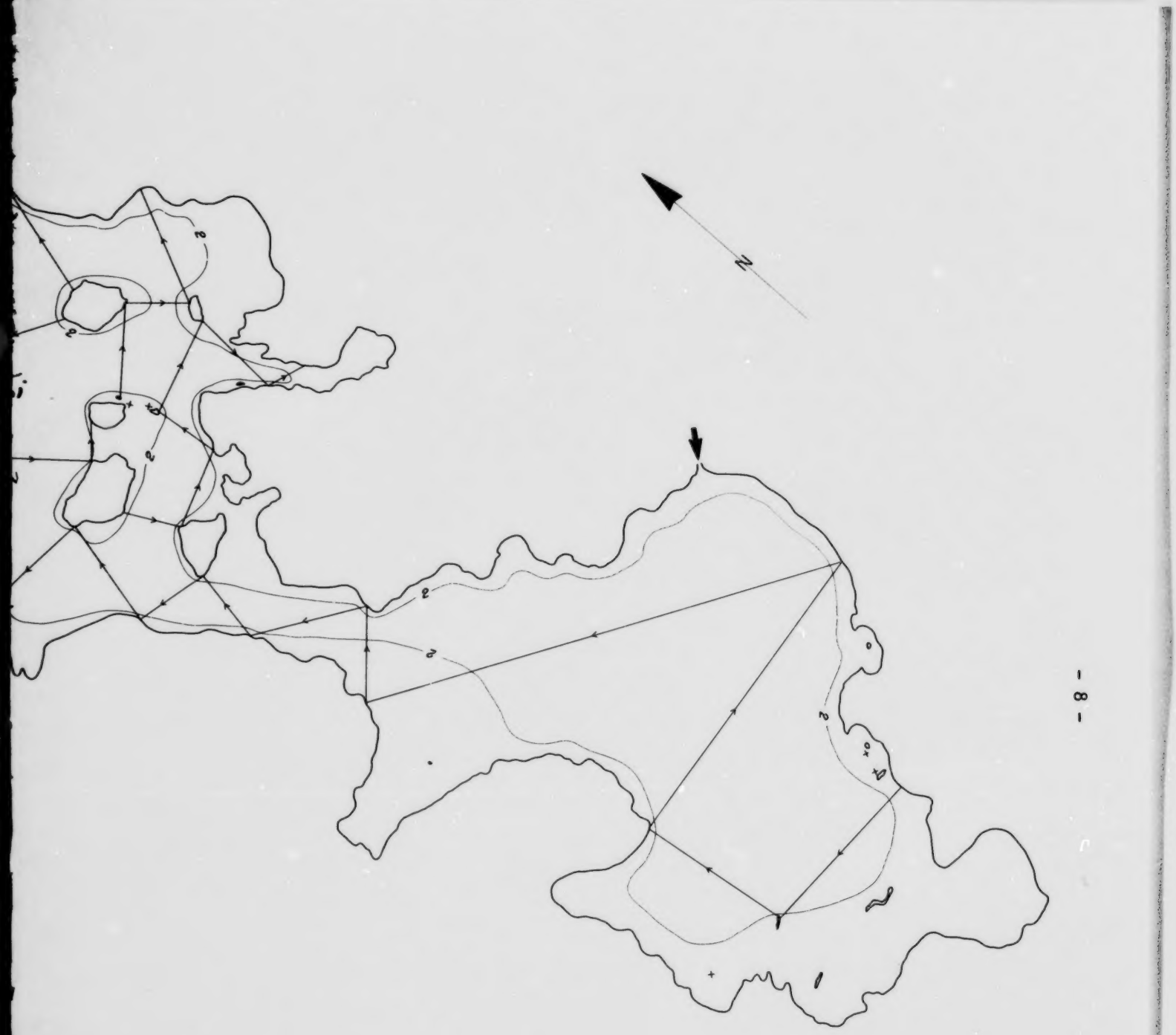


Fig. 4. Bathymetric map of Lynx Lake.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METHODS

Morphometry

The number of transects run for bathymetric mapping varied with each lake and was determined by the complexity of the lake basin. The depth sounding in this survey was done with a Furuno FG200 MK3 unit with a range of 0 to 87 meters. The unit was attached to a 4.3 meter inflatable boat powered by a 20 H.P. outboard. The locations of the transects were drawn on a work map prior to sounding. Some of the transects were later modified after substituting more prominant land marks for reference points. The completed bathymetric maps were used to determine lake area, volume, mean depth and shoreline development according to procedures described by Hutchinson (1957).

Physical and Chemical Parameters

The number of sampling locations for collection of physical and chemical parameters was not fixed and varied according to the complexity of the lake basin and the location of inflowing streams. At each location temperature, dissolved oxygen, conductivity and pH were recorded. The water temperature and dissolved oxygen profiles were recorded at one meter intervals from the surface to the bottom with a YSI electronic instrument. The transparency of the water was measured with a standard limnological Secchi disc, according to Welch (1948). Specific

conductivity was measured at the surface with a YSI electronic instrument. The pH at each location was measured with a Hach wide range colour comparator field kit.

The number of locations for collection of water samples for chemical analysis was two per lake. Two one liter and one 500 ml samples were collected from each station. The 500 ml sample was fixed with 2.5 ml nitric acid (50%). The samples were submitted for analysis within 24 hours of being collected. The analyses of the water samples were done by the Environmental Management Division of the Department of Consumer and Corporate Affairs and Environment.

Plankton

Plankton samples were collected at the water chemistry locations with a 24 cm diameter Wisconsin plankton net of 73 μ Nitex. The samples were preserved in the field in 10% formalin. Identification of the plankton was made in the laboratory.

Benthos

Benthos samples were also collected from the water chemistry locations with a 15 cm by 15 cm Ekman dredge. The samples were washed in the field in a 400 μ Nitex bag and preserved in 10% formalin for later identification and analysis.

Fish

Small fish specimens (forage fish) were collected by seining a suitable area with a 1.2m by 7.4m minnow seine of 6mm oval mesh. These were supplemented with samples taken with the fish toxicant, rotenone. A small bay or area of the lake was selected, preferably one that could be blocked off with the seine, and 1 litre of rotenone was then gradually dispensed into the water in the prop wash. It was thoroughly mixed into the water by traversing the treated area by boat several times. The fish were picked up with a small dip net as they rose to the surface.

The sport species and other large fish were captured with standard gang gill nets. Each standard gang consisted of six gill nets with the mesh sizes in the following sequence: 3.8 cm, 9.5 cm, 5.1 cm, 10.8 cm, 7.6 cm, and 12.7 cm. Each gillnet in the standard gang was 22.9m long and 1.8m deep. The standard gang net sets were rotated around the lake to sample as many different habitat types and depth zones as possible. The gangs were set overnight for approximately 16 hrs. The number of fish captured in each gill net was recorded. The sport species, walleye (Stizostedion vitreum) and northern pike (Esox lucius), were sampled for fork length, weight, sex, maturity and stomach contents. For age determination, the otoliths and first two dorsal spiny rays were taken from walleye and the first two pelvic rays were taken from the northern pike. All other species of fish were measured for fork length and weight only. Preparation and ageing of the otoliths

and pelvic rays only were performed according to the procedures outlined by Erickson (1979).

Calculations

The morphoedaphic index (MEI) was calculated according to Ryder (1965). Procedures described by Snedecor and Cochran (1967) were followed for statistical analyses. The mean weighted age of onset of sexual maturity was calculated by the equation:

$$Z = \frac{A_1K_1 + A_2\ (K_2-K_1) + A_3\ (K_3-K_2) + \ldots\ A_n\ (K_n-K_{n-1})}{K_1 + (K_2 -K_1) + (K_3 -K_2) + \ldots\ (K_n-K_{n-1})}$$

where A = age (years)

K = % of mature fish in the n^{th} age class.

This is a corrected form of Abrasov's (1967) formula. Asymptotic length (L_∞) was determined from a plot of l_{t+1} vs l_t as described by Walford (1946). L_∞ is the length at which the Walford line intersects a 45^o diagonal from the origin. The trophic state of the lakes was determined from the trophic state index (TSI) described by Carlson (1977).

RESULTS

Morphometry

The watershed divisions that contain the study lakes are summarized in Table 1. Also shown is the area of each watershed unit (Fedoruk 1970).

Table 1. Drainage divisions and watershed units of Manitoba that contain the lakes surveyed.

Principal Drainage Division			Major Drainage Division			Watershed Unit			Lake
No.	Name	Approx. area in Manitoba in Km²	No.	Name	Approx. area in Manitoba in Km²	No.	Name	Approx. area in Manitoba in Km²	
5	Nelson River	313,131	5RE	Poplar River	9,705	5REK	Ewart Lake	290	Morfee Ewart Lynx
						5REJ	Carr-Harris Lake	192	Carr-Harris

The morphometry of the lakes surveyed was fairly diverse. The shoreline development index ranged from 3.1 on Lynx Lake to 5.3 on Morfee Lake. The morphometry of the lakes is summarized in Table 2. Bathymetric maps of the lakes are presented in Figs. 2 to 5. All depth contours are in meters.

Physical and Chemical Parameters

The Secchi disc transparencies (m) for each lake were as follows:

Morfee	1.4	August 5, 1979
Ewart	1.2	August 4, 1979
Lynx	1.1	August 12, 1979
Carr-Harris	1.2	August 12, 1979

Temperature-dissolved oxygen profiles of the lakes showed each to be isothermal with saturated or near saturated levels of dissolved oxygen (Fig. 6). The locations of the sampling stations are illustrated in Figs. 7 to 10.

The average values for field measurements of pH and specific conductivity were close to the values obtained from the lab analysis of the water samples (Table 3).

Dissolved minerals in these lakes were dominated by bicarbonates and sodium (Table 3). The specific conductivity (μmho/cm ranged from 22.2 in Carr-Harris to 37.3 in Lynx and the total dissolved solids ranged from 56.0 mg/l in Carr-Harris to 61.0 mg/l in Ewart.

Table 2. Morphometry of the lakes surveyed.

Measurement	Morfee	Ewart	Lynx	Carr-Harris
Area (ha)	508	483	371	1089
Maximum depth (m)	10.0	5.0	2.0	8.0
Mean depth (m)	1.8	1.9	1.6	1.9
Volume ($m^3 x 10^6$)	9.2	8.7	6.1	20.4
Length of shoreline (km)	42.3	31.9	20.9	45.0
Length of island shoreline (km)	13.3	5.2	4.2	32.1
Total length of shoreline (km)	55.6	37.1	25.1	77.1
Shoreline development index	5.3	4.2	3.1	3.8

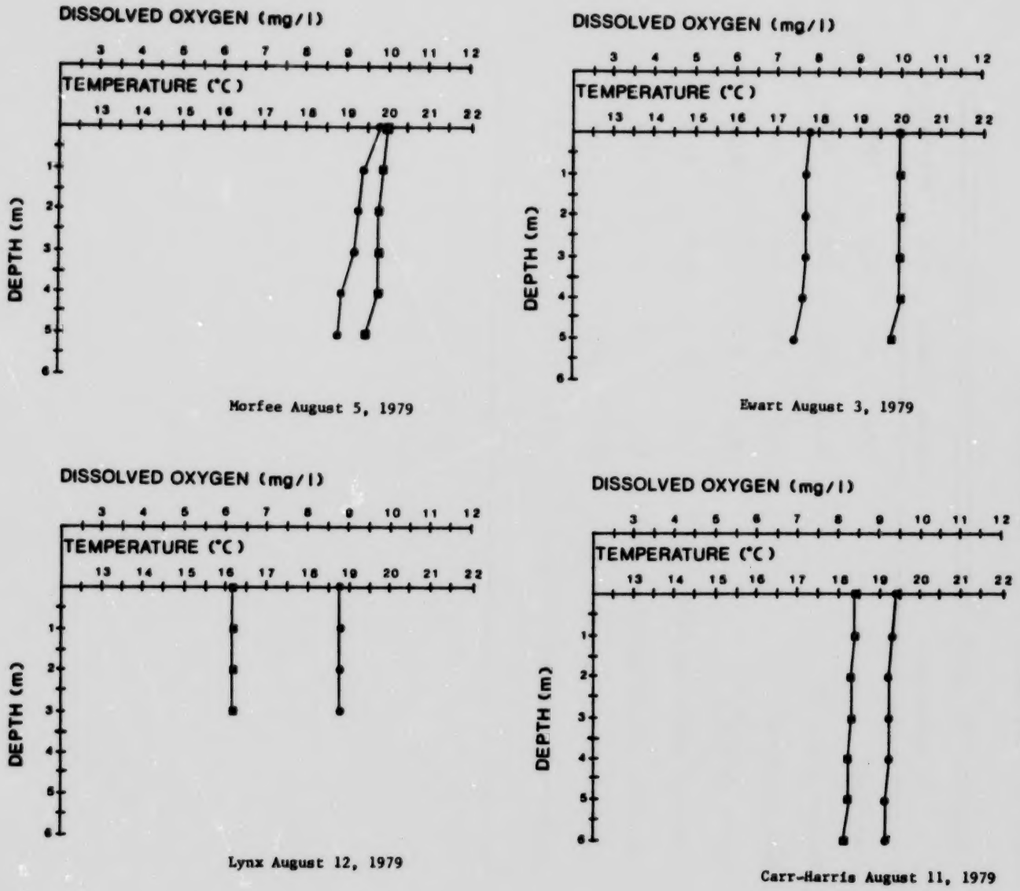


Fig. 6. Temperature ■—■ dissolved oxygen ●—● profiles of the inventory lakes.

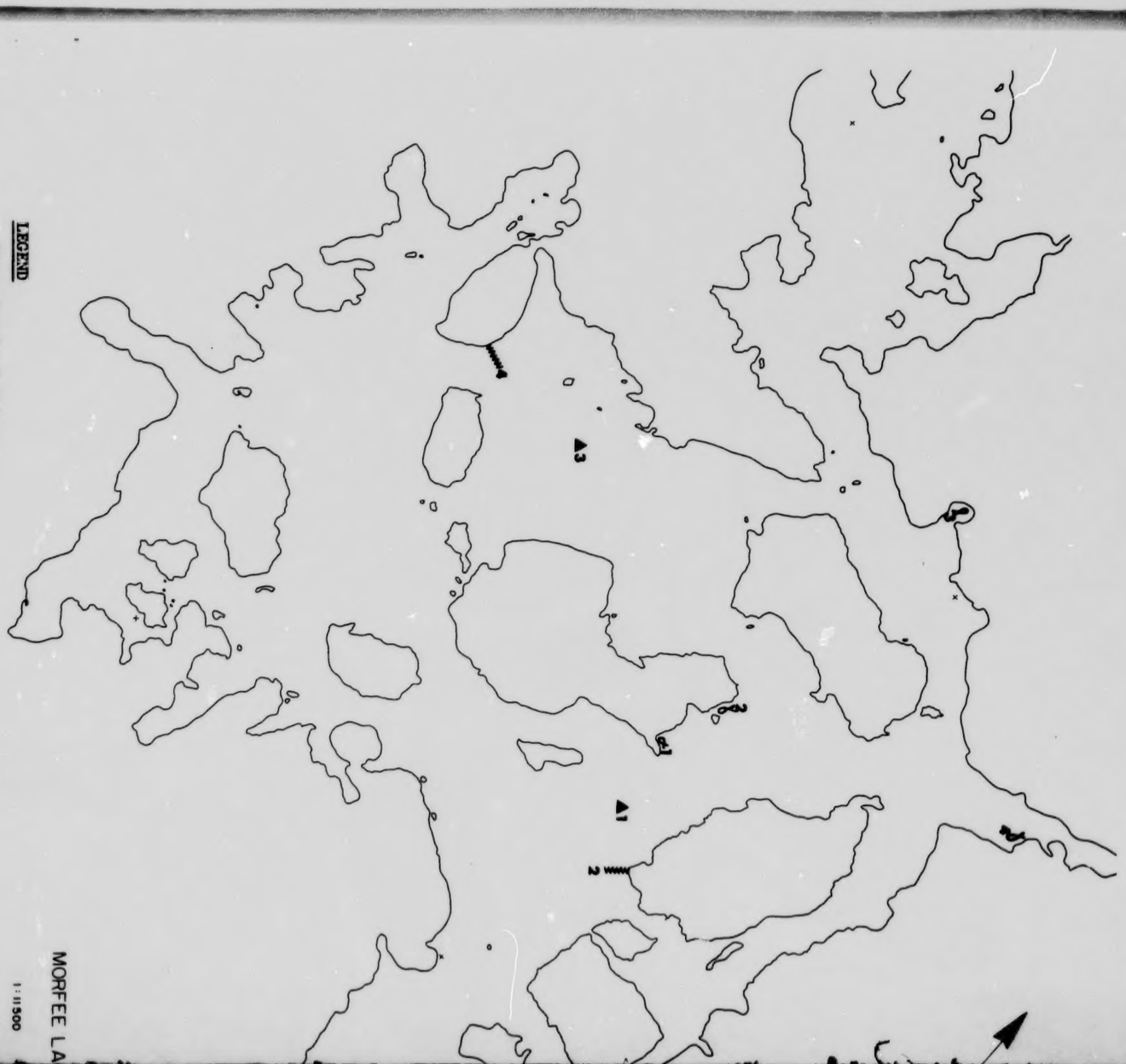
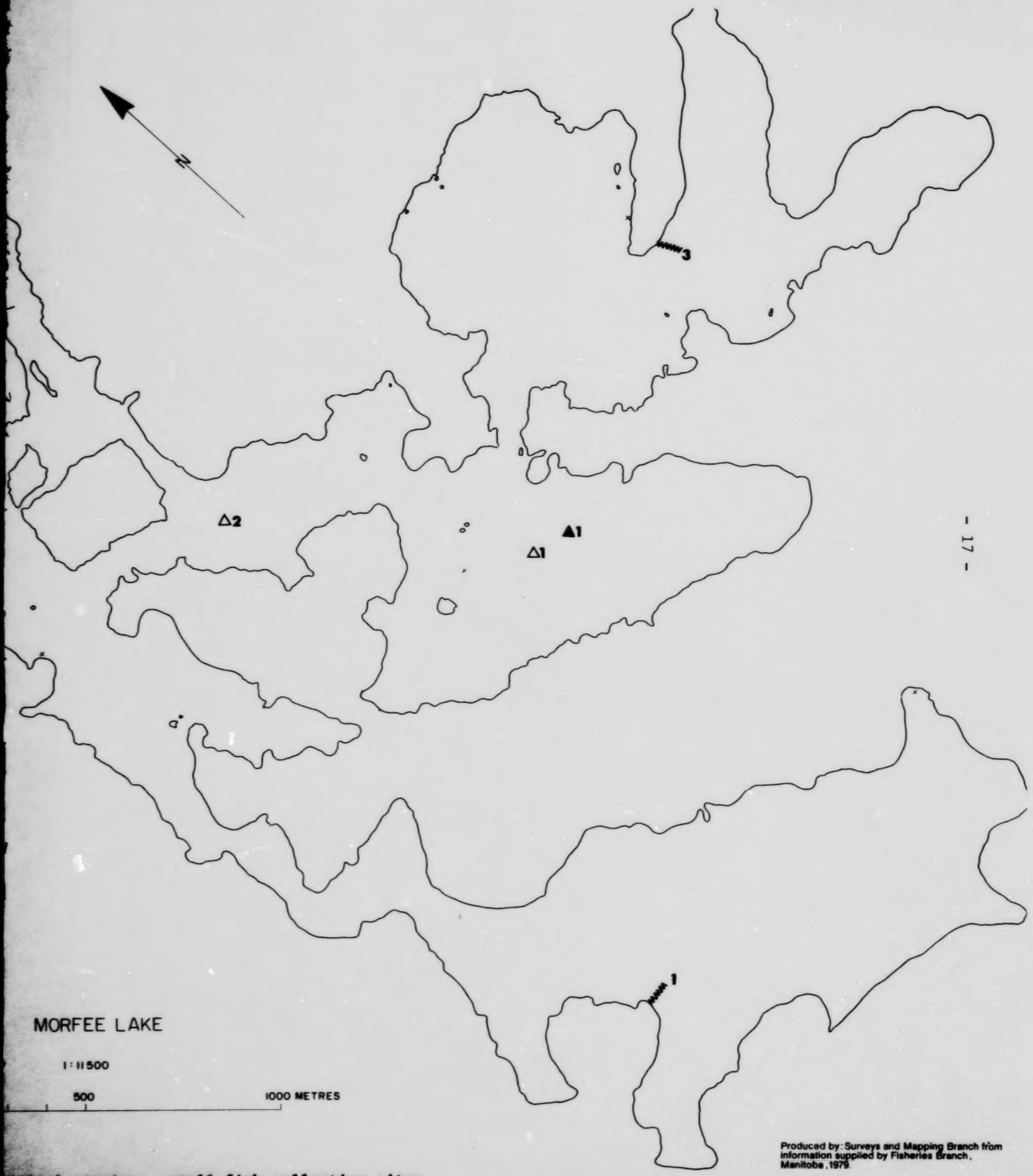


Fig. 7. Location of chemical station
and gill net sets in Morfee



ical stations, small fish collection sites

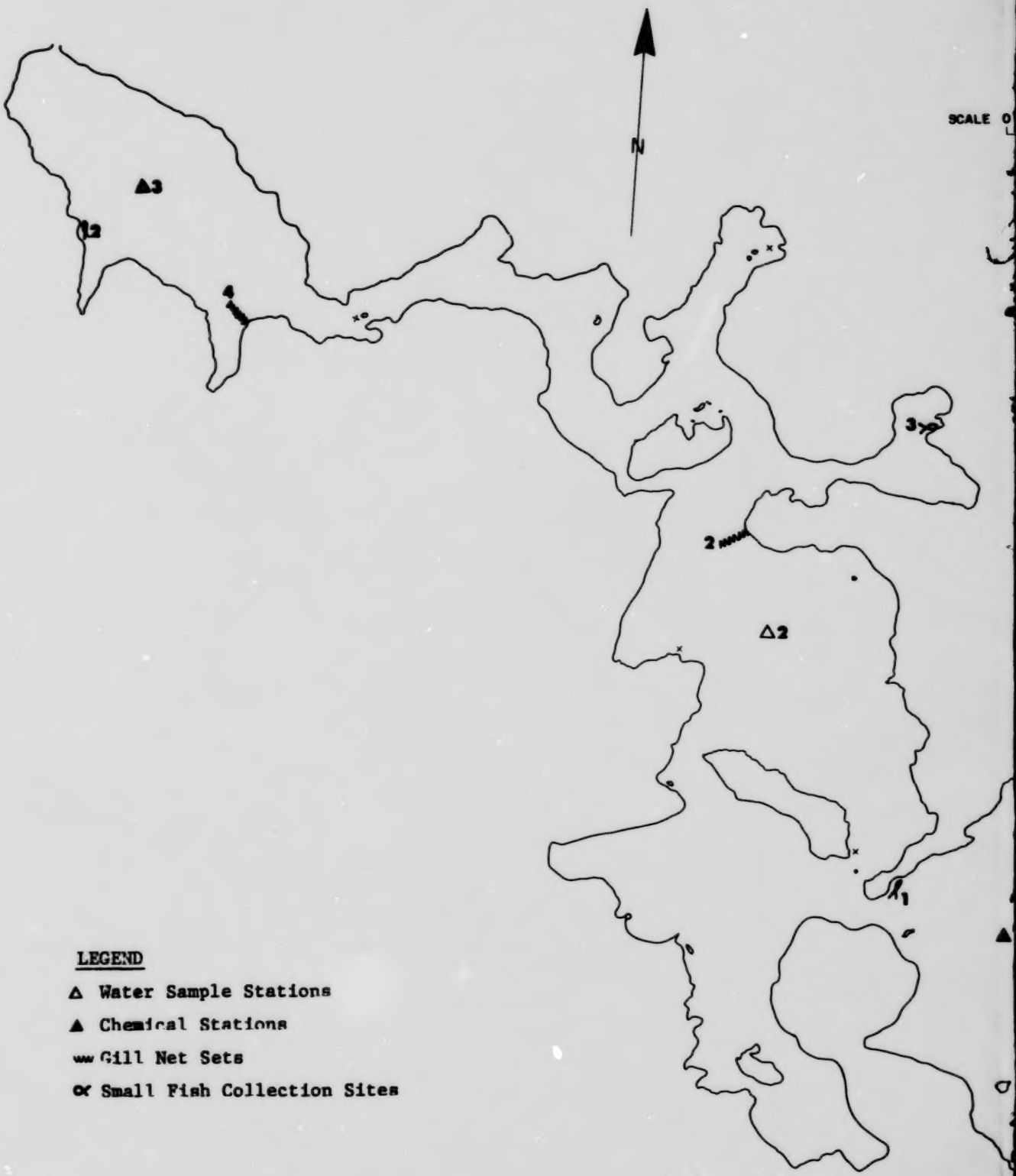
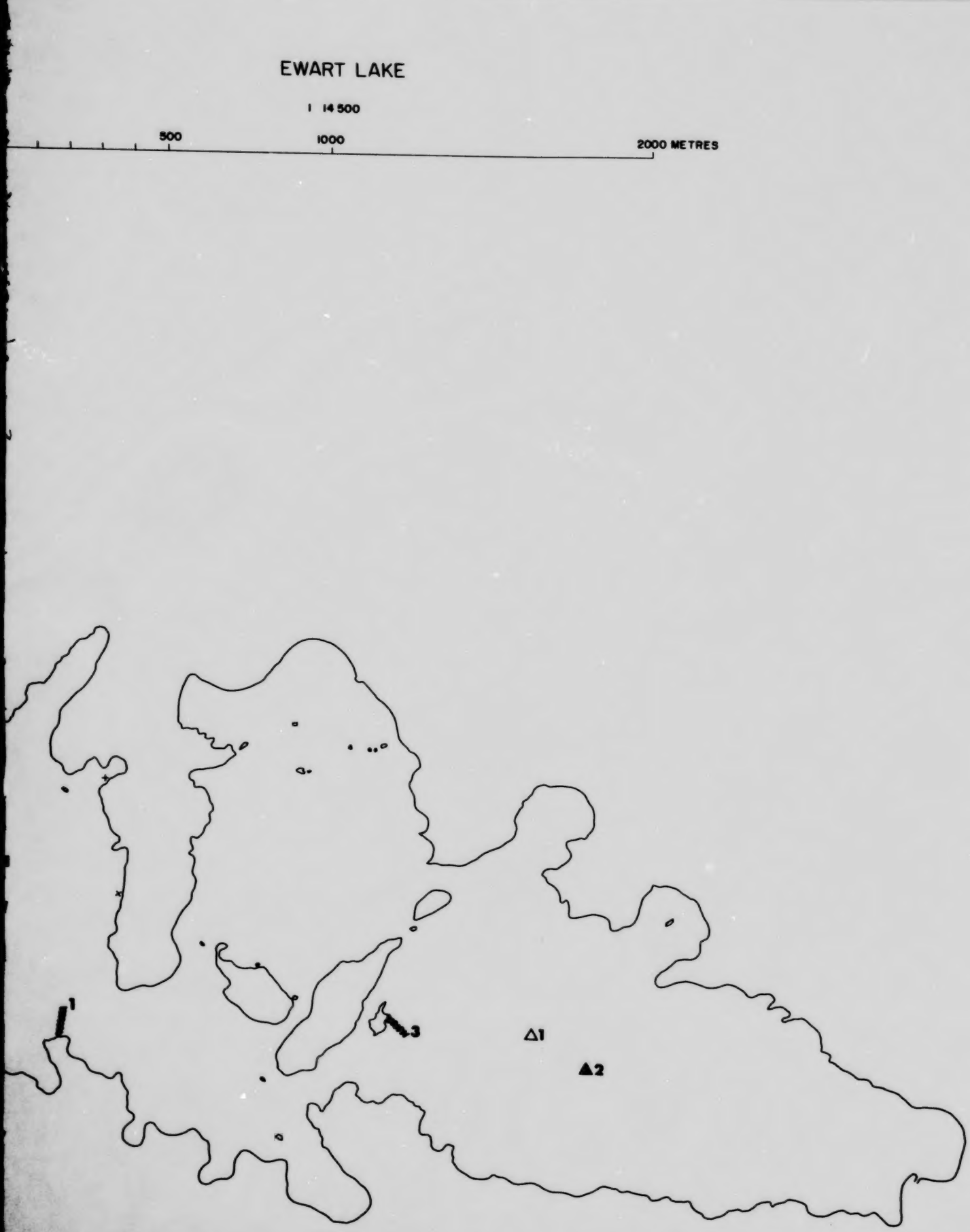


Fig. 8. Location of



...mical stations, small fish collection sites
... in Ewart Lake.

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LEGEND
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Gill Net Sets
Small Fish Collection Sites

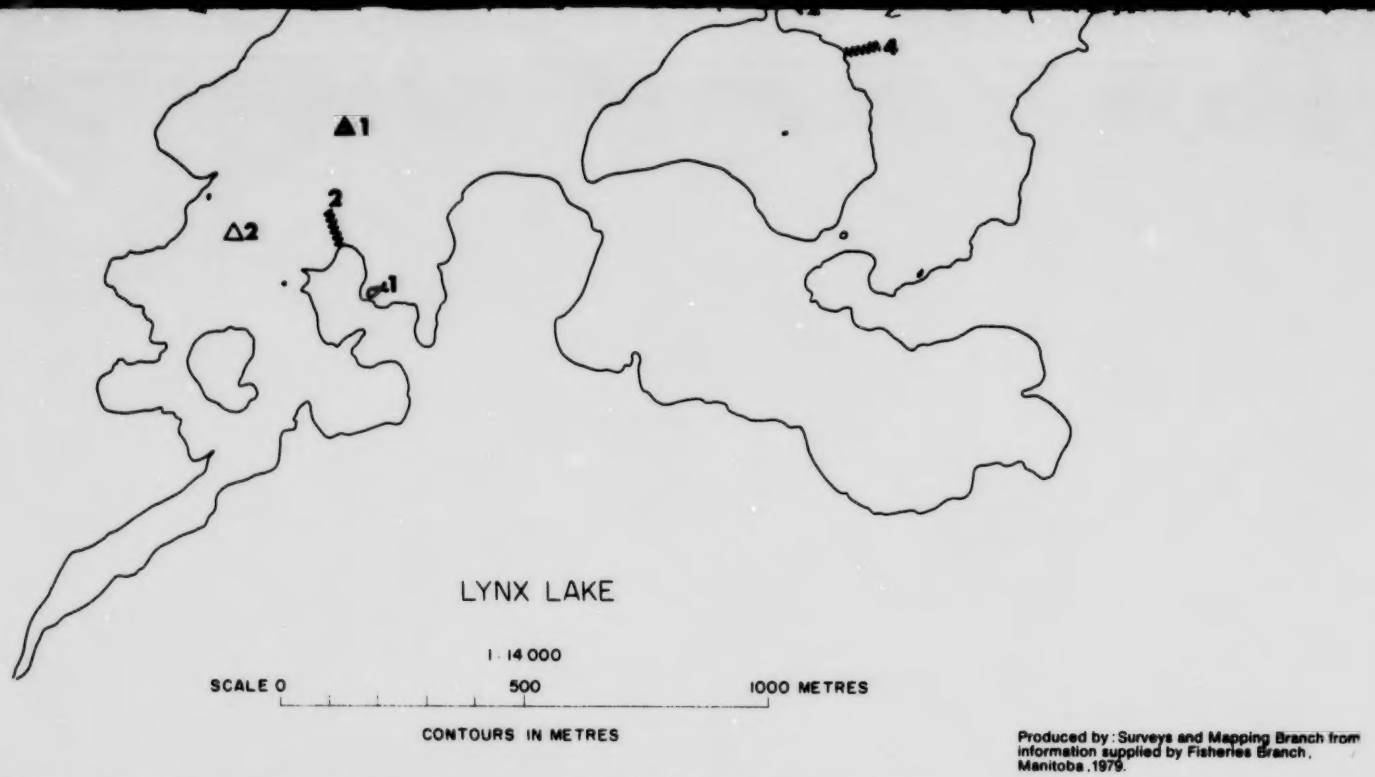
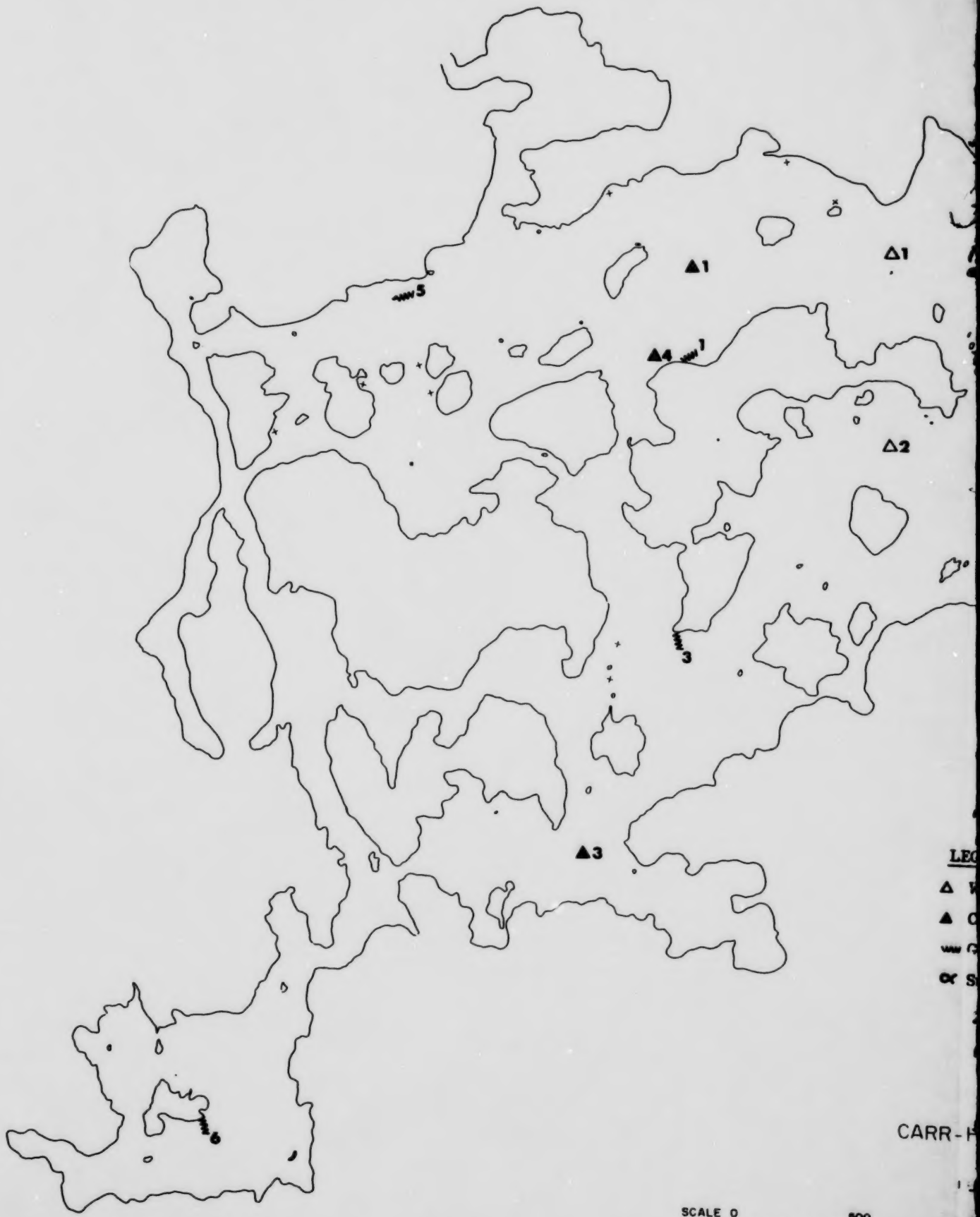


Fig. 9. Location of chemical stations, small fish collection sites and gill net sets in Lynx Lake.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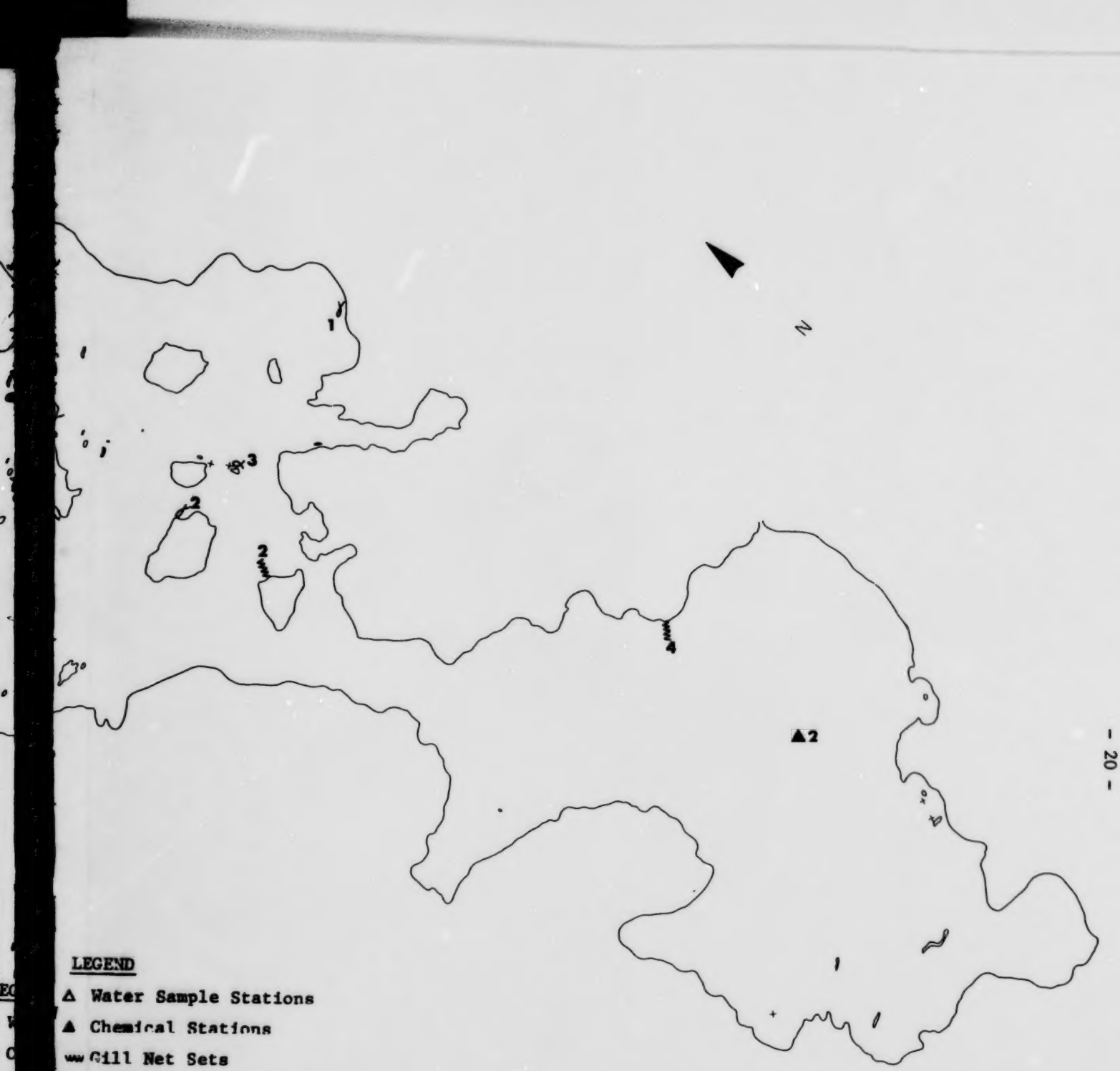

RR-HARRIS LAKE

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Fig. 10. Location of chemical stations, small fish collection sites and gill net sets in Carr-Harris Lake.

Produced by: Surveys and Mapping Branch from information supplied by Fisheries Branch, Manitoba, 1979.

Table 3. Water chemistry analysis of the lakes - July 25, 1979.

	Morfee	Ewart	Lynx	Carr-Harris
Conductivity (Field) (µmho/cm)	52.0 @ 19.5C	27.0 @ 19.8C	33.0 @ 19C	29.0 @ 18.6C
Conductivity (Lab) (µmho/cm)	29.2	29.9	37.3	22.2
Residue (Total) (mg/l)	60.0	61.0	57.0	56.0
Residue (Filterable) (mg/l)	60.0	61.0	57.0	56.0
Residue (Nonfilterable) (mg/l)	<5.0	<5.0	<5.0	<5.0
pH (Field)	6.95	6.98	7.16	6.62
pH (Lab)	6.9	6.85	6.95	6.7
Alkalinity (Total) ($CaCO_3$) (mg/l)	13.0	12.0	15.0	11.0
Alkalinity (HCO_3) (mg/l)	15.8	14.6	18.2	13.4
Alkalinity (CO_3) (mg/l)	0.0	0.0	0.0	0.0
Alkalinity (OH) (mg/l)	0.0	0.0	0.0	0.0
Calcium (Ext) (mg/l)	<5.0	<5.0	<5.0	<5.0
Magnesium (Ext) (mg/l)	<5.0	<5.0	<5.0	<5.0
Hardness ($CaCO_3$) (mg/l)	<33.0	<33.0	<33.0	<33.0
Manganese (Ext) (mg/l)	0.06	0.03	0.04	0.02
Iron (Ext) (mg/l)	0.17	0.27	0.37	0.61
Potassium (Ext) (mg/l)	<2.0	<2.0	<2.0	<2.0
Sodium (Ext) (mg/l)	<10.0	<10.0	<10.0	<10.0
Total Organic Carbon (mg/l)	24.0	17.0	25.7	21.2
Total Inorganic Carbon (mg/l)	1.5	1.5	3.0	<1.5
Colour (true 0-50 units)	35.0	40.0	45.0	>50.0
Turbidity (NTU)	1.2	1.0	1.0	1.2
Total Kjeldhal N (mg/l)	0.60	0.45	0.65	0.5
NO_3 -NO_2 -N (Diss) (mg/l)	<0.01	<0.04	<0.01	<0.01
Total Phosphorus (mg/l)	0.02	0.02	0.03	0.02
Chlorine (Sol)	<2.0	<2.0	<2.0	<2.0
Sulfate (Sol) (mg/l)	6.5	8.0	8.0	6.5

Nutrient concentrations of the lakes were quite low. The total dissolved nitrogen, nitrites and nitrates was <0.01 mg/l in Morfee and Lynx lakes, 0.01 mg/l in Carr-Harris and 0.04 mg/l in Ewart Lake. The value for Ewart Lake is probably a sampling anomaly or an analytical error as the total Kjeldhal nitrogen for Ewart Lake was the least at 0.45 mg/l (Table 3). The total phosphorus concentration was 0.02 mg/l for Morfee, Ewart and Carr-Harris lakes and 0.03 mg/l in Lynx Lake.

Plankton and Benthos

Although there were numerous genera of pytoplankton and zooplankton identified from each lake, there were only 19 genera of phytoplankton and 9 genera of zooplankton common to the inventory lakes. The results are summarized in Appendices 1 to 4.

Fish

Eleven species of small fish were collected from Morfee, Ewart, Lynx and Carr-Harris lakes during this survey. The most abundant species in all the lakes was burbot (Lota lota) followed by yellow perch (Perca flavescens). The most abundant species within a lake were emerald shiners (Notropis atherinoides) in Ewart Lake. A summary of those species captured is presented in Table 4. Sampling locations are shown in Figs. 7 to 10.

A total of 18 standard gangs were set in the four

Table 4. Small fish collected from the study lakes.

Species	No. of fish from -			
	Morfee	Ewart	Lynx	Carr-Harris
Yellow perch (*Perca flavescens*)	13	10	13	64
Burbot (*Lota lota*)	26	45	87	8
Northern pike (*Esox lucius*)	5	1	3	2
Spottail shiner (*Notropis hudsonius*)	63	-	-	58
Slimy sculpin (*Cottus cognatus*)	7	-	-	3
Johnny darter (*Etheostoma nigrum*)	1	7	25	80
Iowa darter (*Etheostoma exile*)	1	4	-	-
Mimic shiner (*Notropis vollucellus*)	35	-	-	-
Walleye (*Stizostedion vitreum*)	4	-	1	3
Emerald shiner (*Notropis atherinoides*)	-	166	-	-
White sucker (*Catostomus commersoni*)	-	-	-	19

inventory lakes. There were four gangs set in Morfee, Ewart and Lynx lakes and six gangs in Carr-Harris Lake. Only four species of fish were taken in these sets; walleye, northern pike, yellow perch and white sucker (Catostomus commersoni). The most abundant species in each lake was walleye, which comprised more than 50% of the catch in each lake. The total catches of the standard gangs are summarized in terms of number and total weight per mesh size in Tables 5 to 8. The locations of the standard gang sets are illustrated in Figs. 7 to 10.

Walleye Age and Growth

The age structures of the walleye populations from Morfee, Ewart, Lynx and Carr-Harris lakes are summarized in Table 9. A comparison of the age-frequency distributions for walleye from the inventory lakes (Fig. 11) shows good representation of most age groups and a relatively high proportion of older age groups (10+ years), indicating a low mortality rate. The modal ages of the Morfee and Ewart walleye samples were 9 years. The mean ages of these samples were 8 and 9.4 years respectively. Lynx Lake walleye had a modal age of 5 years and a mean age of 9.9 years. The Carr-Harris walleye sample had a modal age of 8 years and a mean age of 8.3 years.

The points on the length-weight curves presented in this report are age-specific mean lengths and weights. The length-weight

Table 5. Number and total weight of fish of each species caught in each mesh from Morfee Lake.

Species		Mesh size 3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Northern pike	No.	1	9	8	-	-	-	18	16.5
(Esox lucius)	kg.	0.6	4.5	7.0				12.1	
Walleye	No.	1	15	35	2	-	-	53	48.6
(Stizostedion vitreum)	kg.	0.6	5.2	14.7	0.6			21.1	
White sucker	No.	-	3	7	16	8	2	36	33.0
(Catostomus commersoni)	kg.		2.4	5.8	11.6	10.4	2.8	33.0	
Yellow perch	No.	-	-	2	-	-	-	2	1.9
(Perca flavescens)	kg.			0.3				0.3	
Total	No.	2	27	52	18	8	2	109	
	kg.	1.2	12.1	27.8	12.2	10.4	2.8	66.5	
Mean no. walleye/mesh		0.2	3.7	8.7	0.5	0.0	0.0		
Mean no. pike/mesh		0.2	2.2	2.0	0.0	0.0	0.0		
Mean no. fish/mesh		0.5	6.8	13.0	4.5	2.0	0.5	27.2	
Mean biomass/mesh		0.3	3.0	6.9	3.0	2.6	0.7	16.6	

Table 6. Number and total weight of fish of each species caught in each mesh from Ewart Lake.

Species		Mesh size 3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Northern pike	No.	-	2	4	1	-	-	7	8.3
(Esox lucius)	kg.		0.3	3.5	2.2			6.0	
Walleye	No.	4	16	12	14	7	-	53	63.1
(Stizostedion vitreum)	kg.	11.7	7.9	6.5	10.0	6.4		42.5	
White sucker	No.	-	-	-	3	5	1	9	10.7
(Catostomus commersoni)	kg.				3.4	4.6	1.8	9.8	
Yellow perch	No.	10	5	-	-	-	-	15	17.9
(Perca flavescens)	kg.	0.3	0.3					0.6	
Total	No.	14	23	16	18	12	1	84	
	kg.	12.0	8.5	10.0	15.6	11.0	1.8	58.9	
Mean no. walleye/mesh		1.0	4.0	3.0	3.5	1.7	0.0		
Mean no. pike/mesh		0.0	0.5	1.0	0.2	0.0	0.0		
Mean no. fish/mesh		3.5	5.8	4.0	4.5	3.0	0.2	21.0	
Mean biomass/mesh		3.0	2.1	2.5	3.9	2.8	0.4	14.7	

Table 7. Number and total weight of fish of each species caught in each mesh from Lynx Lake.

Species		Mesh size 3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Northern pike *(Esox lucius)*	No.	5	2	5	-	-	-	12	8.6
	kg.	1.9	1.4	3.8				7.1	
Walleye *(Stizostedion vitreum)*	No.	6	16	40	18	5	2	87	62.6
	kg.	2.4	7.1	23.4	11.8	4.3	1.4	50.4	
White sucker *(Catostomus commersoni)*	No.	-	-	2	4	2	6	14	10.1
	kg.			2.5	4.2	11.2	11.2	29.1	
Yellow perch *(Perca flavescens)*	No.	2	9	14	1	-	-	26	18.7
	kg.	0.5	1.5	4.3	0.5			6.8	
Total	No.	13	27	61	23	7	8	139	
	kg.	4.8	10.0	34.0	16.5	15.5	12.6	93.4	
Mean no. walleye/mesh		1.5	4.0	10.0	4.5	1.2	0.5		
Mean no. pike/mesh		1.2	0.5	1.2	0.0	0.0	0.0		
Mean no. fish/mesh		3.2	6.8	15.2	5.8	1.8	2.0	34.7	
Mean biomass/mesh		1.2	2.5	8.5	4.1	3.9	3.1	23.3	

Table 8. Number and total weight of fish of each species caught in each mesh from Carr-Harris Lake.

Species		Mesh size 3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Northern pike	No.	2	9	2	1	2	-	17	13.5
(Esox lucius)	kg.	4.7	5.2	5.5	0.8	8.9		25.1	
Walleye	No.	23	11	27	5	3	1	70	55.6
(Stizostedion vitreum)	kg.	4.7	4.1	11.9	1.7	6.6	0.8	29.8	
White sucker	No.	-	-	-	4	6	1	11	8.7
(Catostomus commersoni)	kg.				9.2	7.1	1.5	17.8	
Yellow perch	No.	7	13	7	-	1	-	28	22.2
(Perca flavescens)	kg.	0.6	1.3	1.9		0.2		4.0	
Total	No.	32	33	36	10	13	2	126	
	kg.	10.0	10.6	19.3	11.7	22.8	2.0	76.7	
Mean no. walleye/mesh		3.8	1.8	4.5	0.8	0.5	0.2		
Mean no. pike/mesh		0.3	1.5	0.3	0.2	0.3	0.0		
Mean no. fish/mesh		5.3	5.5	6.0	1.7	2.2	0.3	21.0	
Mean biomass/mesh		1.7	1.8	3.2	1.9	3.8	0.4	12.8	

Table 9. Age-specific mean fork lengths, weights and condition factors for walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

Age	MORFEE					EWART				
	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	2	3.92	205.00	100.00	1.17
3	2	4.08	276.00	205.00	0.97	4	7.84	292.00	260.00	1.02
4	2	4.08	294.00	242.50	0.95	5	9.80	283.60	228.00	0.97
5	9	18.37	323.73	350.56	1.04	-	-	-	-	-
6	6	12.24	329.33	353.33	0.99	1	1.96	320.00	312.00	0.95
7	1	2.04	340.00	390.00	0.99	3	5.88	362.67	493.33	1.02
8	9	18.37	351.33	415.56	0.96	4	7.84	390.00	630.00	1.04
9	11	22.45	361.64	444.55	0.94	7	13.73	404.00	717.14	1.08
10	3	6.12	362.67	443.33	0.93	4	7.84	390.00	610.00	1.02
11	2	4.08	361.00	435.00	0.93	2	3.92	403.00	700.00	1.08
12	1	2.04	408.00	620.00	0.91	7	13.73	416.00	687.14	0.96
13	-	-	-	-	-	3	5.88	428.00	806.67	1.02
14	-	-	-	-	-	2	3.92	435.00	820.00	0.99
15	-	-	-	-	-	3	5.88	472.00	1006.67	0.96
16	1	2.04	378.00	520.00	0.96	3	5.88	451.33	920.00	0.98
17	-	-	-	-	-	1	1.96	420.00	740.00	1.00
18	-	-	-	-	-					
19	-	-	-	-	-					
20	2	4.08	417.00	607.50	0.84					
21										
22										
23										

cont'd.

Table 9 (cont'd.)

Age	LYNX					CARR-HARRIS				
	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
1	-	-	-	-	-					
2	3	3.45	235.33	126.67	0.98	1	1.54	152.00	30.00	0.85
3	7	8.05	276.29	248.57	1.07	6	9.23	192.50	75.00	1.06
4	7	8.05	324.29	377.14	1.08	3	4.62	240.00	150.00	1.10
5	17	19.54	351.65	490.59	1.12	5	7.69	268.40	220.00	1.14
6	5	5.75	364.40	558.00	1.13	6	9.23	306.67	318.33	1.09
7	5	5.75	405.20	724.00	1.09	4	6.15	312.50	327.50	1.07
8	4	4.60	387.50	625.00	1.08	1	1.54	344.00	450.00	1.11
9	4	4.60	393.00	670.00	1.10	9	13.85	334.00	404.44	1.08
10	1	1.15	412.00	720.00	1.03	9	13.85	343.11	458.89	1.13
11	-	-	-	-	-	5	7.69	342.00	440.00	1.10
12	4	4.60	396.00	740.00	1.19	1	1.54	330.00	410.00	1.14
13	-	-	-	-	-	2	3.08	349.00	510.00	1.19
14	2	2.30	415.00	730.00	1.03	4	6.15	385.00	655.00	1.14
15	3	3.45	408.00	726.67	1.06	2	3.08	365.00	585.00	1.20
16	4	4.60	403.00	665.00	1.01	1	1.54	342.00	440.00	1.10
17	7	8.05	416.57	754.29	1.04	1	1.54	372.00	620.00	1.20
18	6	6.90	404.33	690.00	1.04	2	3.08	368.00	545.00	1.09
19	2	2.30	468.00	1370.00	1.19	2	3.08	399.00	775.00	1.17
20	2	2.30	399.00	640.00	1.01	1	1.54	420.00	780.00	1.05
21	2	2.30	395.00	610.00	1.00					
22	-	-	-	-	-					
23	2	2.30	395.00	600.00	0.98					

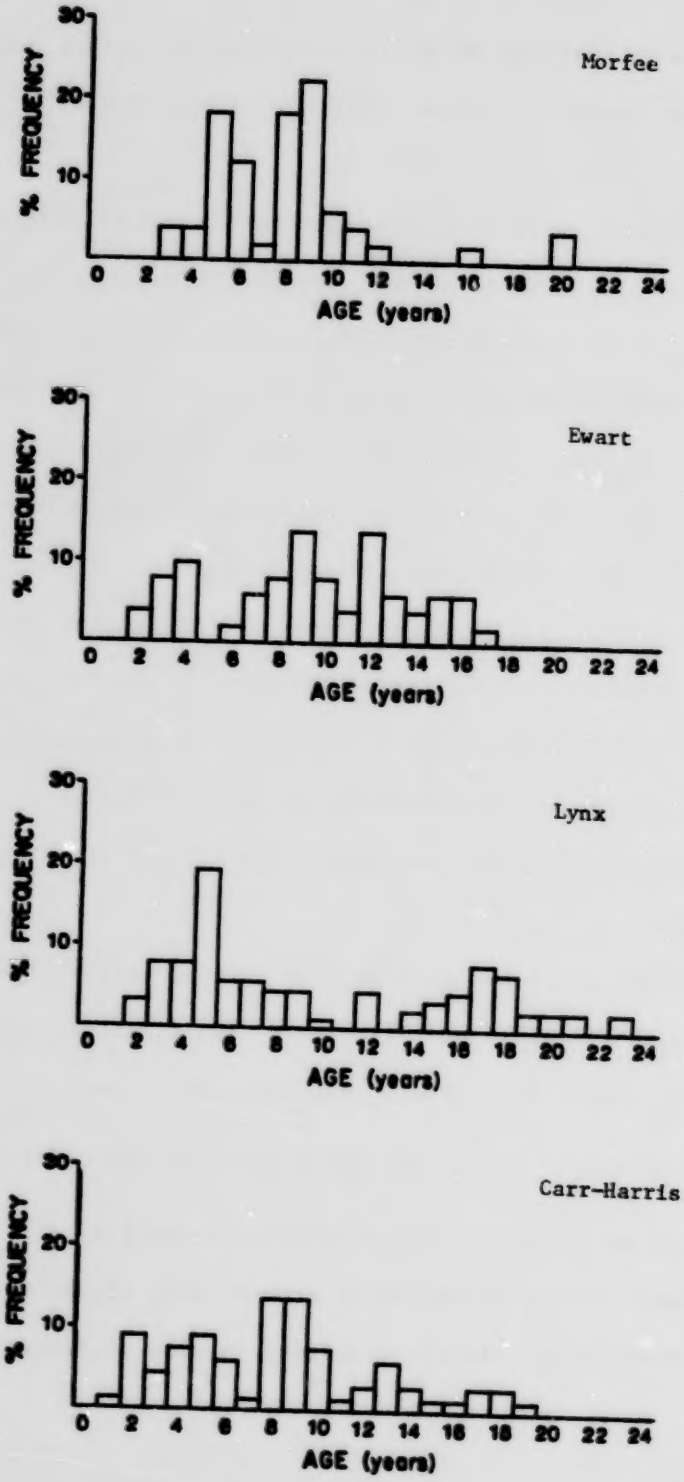


Fig. 11. Age-frequency distribution of walleye from the inventory lakes.

relationships of walleye from Lynx and Carr-Harris lakes showed positive allometric growth while the length-weight relationship of walleye from Morfee and Ewart lakes showed negative allometric growth (Fig. 12, Table 10).

The slope of the length-weight curves for walleye from Morfee and Ewart lakes were the same ($F=1.67$, 1 and 23 d.f., $P \geq 0.05$). There was no significant difference between the slope of the length-weight curves for Lynx and Carr-Harris walleye ($F=1.28$, 1 and 34 d.f., $P \geq 0.05$). There was, however, a significant difference between the slope of the length-weight curves for walleye from Morfee and Carr-Harris lakes ($F=14.79$, 1 and 27 d.f., $P \geq 0.05$). The elevation of the length-weight curves for Morfee and Ewart walleye were significantly different ($F=22.07$, 1 and 23 d.f., $P \geq 0.05$). There was no significant difference between the elevation of the length-weight curves between Lynx and Carr-Harris at $P \geq 0.05$, however at $P \geq 0.01$ there was a significant difference ($F=4.43$, 1 and 35 d.f., $P \geq 0.01$).

Walford plots for walleye from Morfee, Ewart, Lynx and Carr-Harris lakes (Fig. 13 and 14) showed significant relationships of L_{t+1} and l_t (Table 11). The L_∞ estimate was highest for Ewart Lake walleye (479mm). The L_∞ estimates for Lynx and Carr-Harris walleye (407mm and 351mm respectively) were unrealistically low. This is probably due to differential growth rates within year classes and between age classes resulting in wide variances of

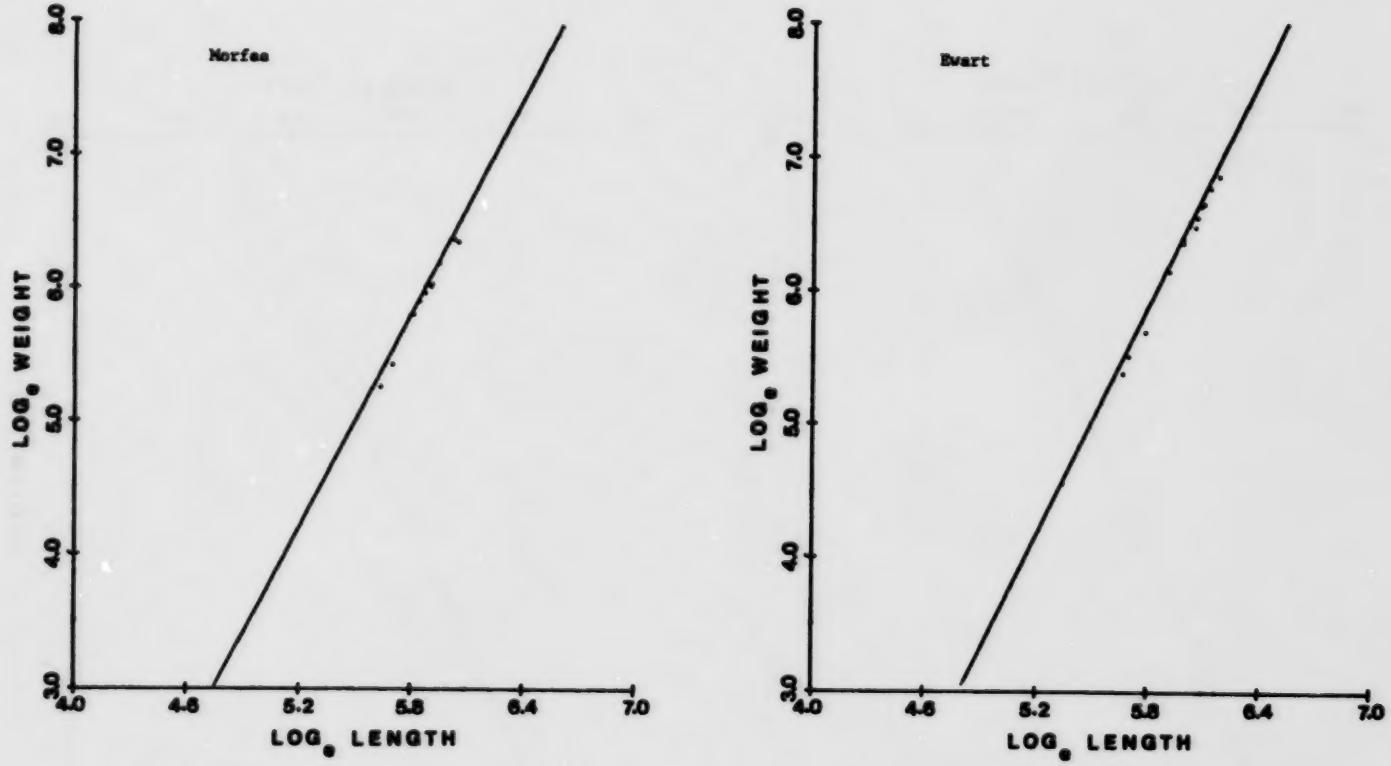


Fig. 12. Length-weight relationship of walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

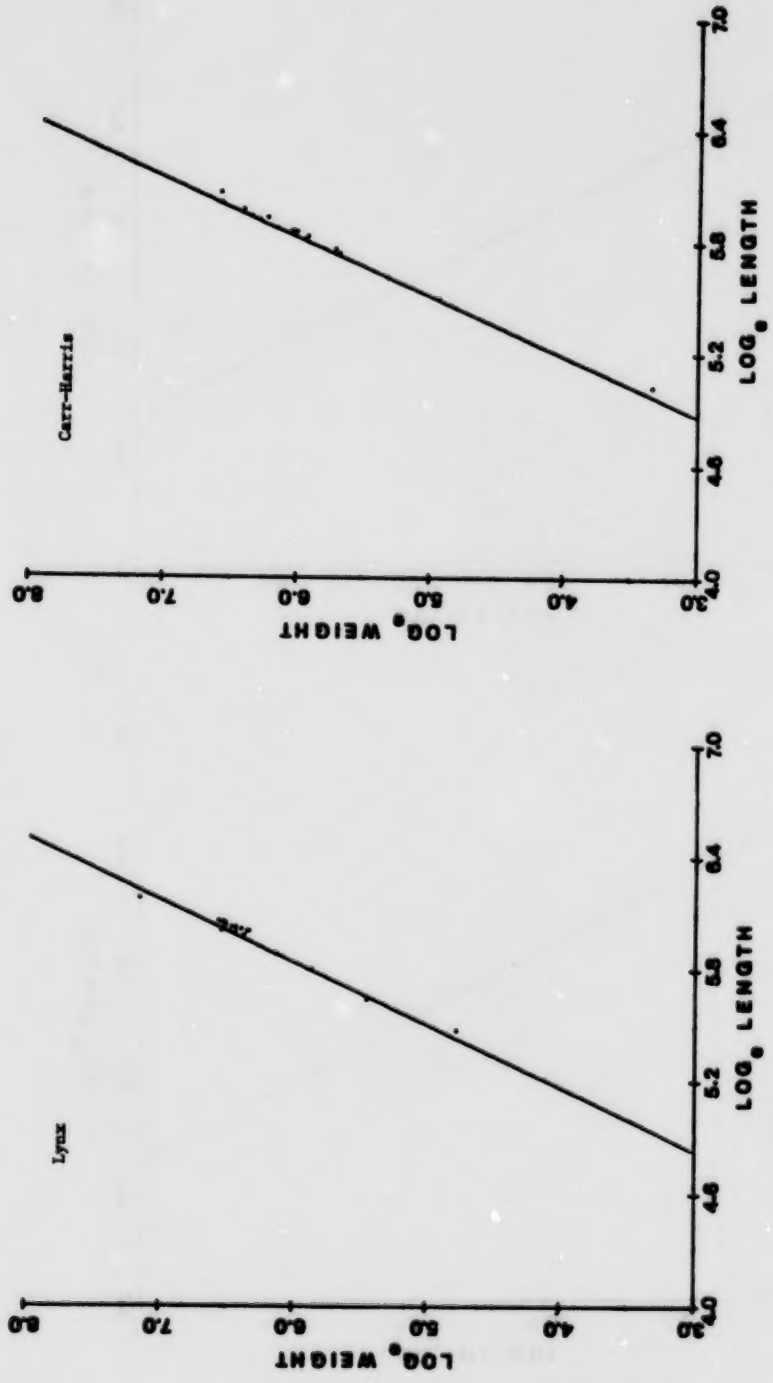


Fig. 12. Continued.

Table 10. Length-weight relationships of walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

Lake	Length-weight equation	Correlation Coefficient	Test F value	d.f.
Morfee	Log_e weight = - 8.694 + 2.510 Log_e length	0.916*	247.20	1,47
Ewart	Log_e weight = -10.866 + 2.893 Log_e length	0.989*	2378.16	1,49
Carr-Harris	Log_e weight = -12.048 + 3.110 Log_e length	0.992*	3583.65	1,63
Lynx	Log_e weight = -11.677 + 3.040 Log_e length	0.985*	2717.82	1,85

* Significant at $P \geq 0.05$.

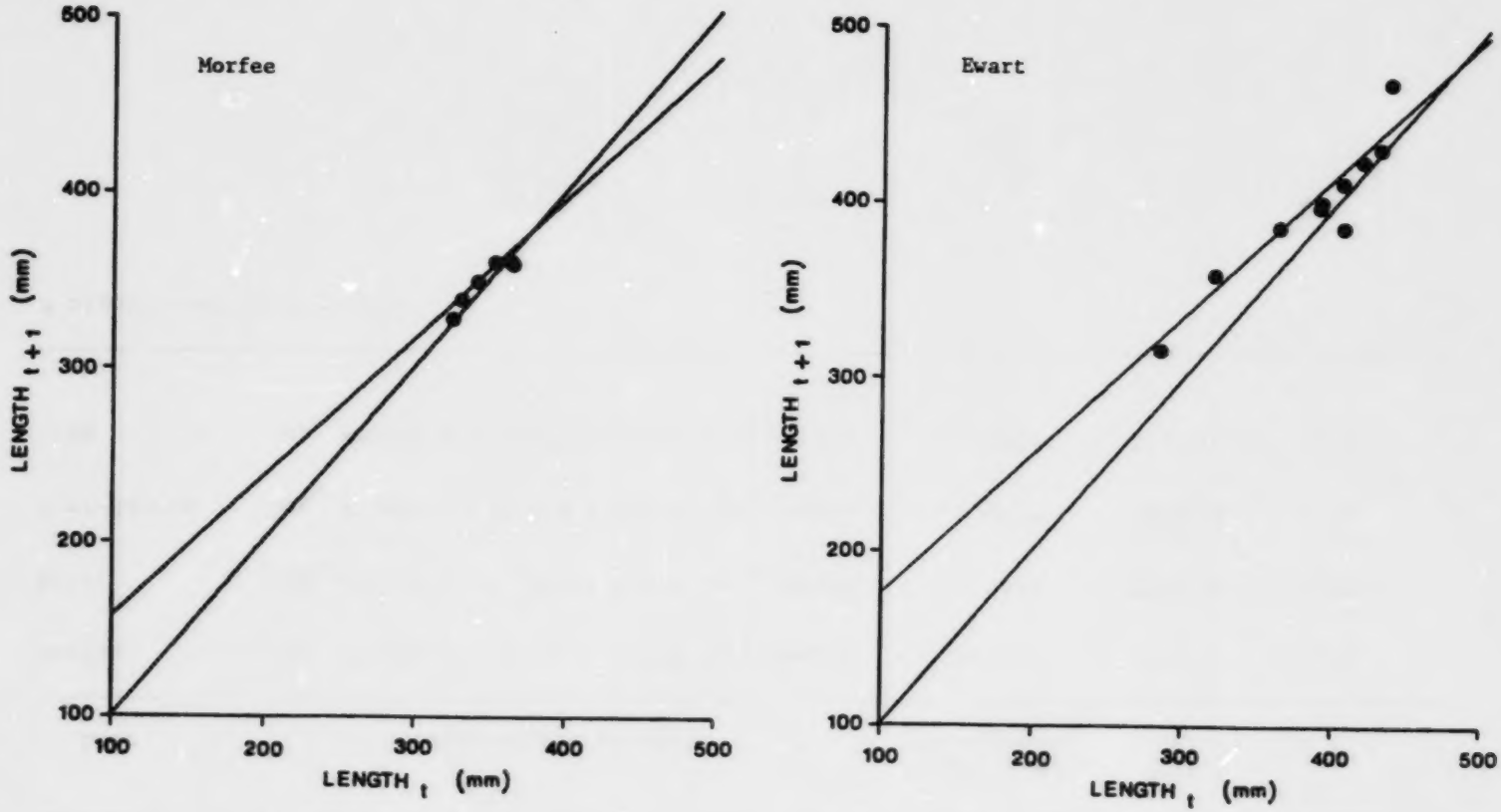


Fig. 13. Walford plots of walleye from Morfee and Ewart lakes.

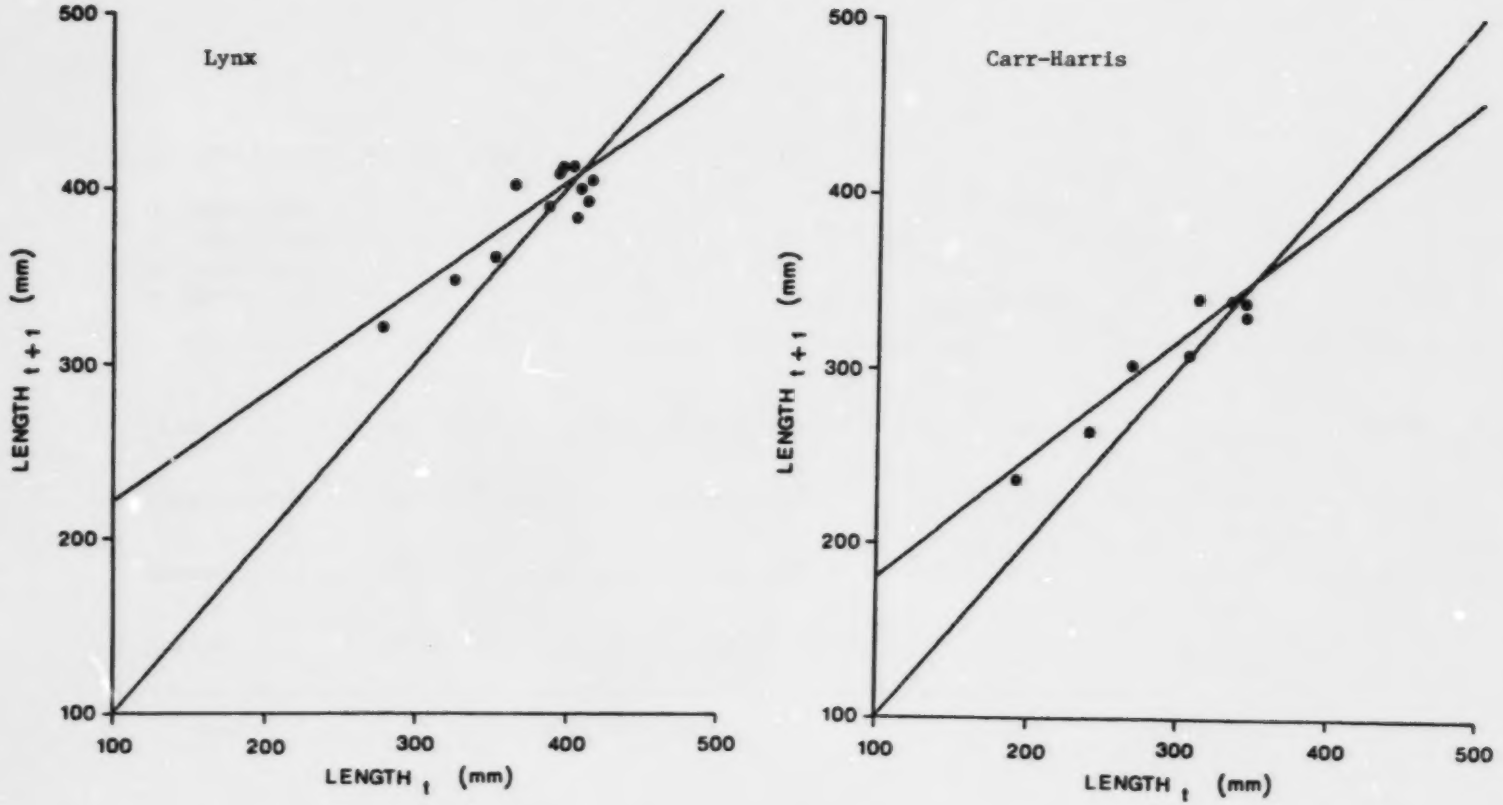


Fig. 14. Walford plots of walleye from Lynx and Carr-Harris lakes.

Table 11. Linear equations of walford plots for walleye from the inventory lakes fitted by least squares regression.

Lake	Linear equation		L_∞ (mm)	Correlation Coefficient	Test F Value	d.f.
Morfee	$\text{Log}_e L_{t+1} = 77.763 + 0.793\ \text{Log}_e L_t$	a	374	0.955*	41.40	1,4
Ewart	$\text{Log}_e L_{t+1} = 94.244 + 0.803\ \text{Log}_e L_t$	b	479	0.939*	60.10	1,8
Carr-Harris	$\text{Log}_e L_{t+1} = 112.187 + 0.680\ \text{Log}_e L_t$	c	351	0.960*	70.74	1,6
Lynx	$\text{Log}_e L_{t+1} = 159.478 + 0.609\ \text{Log}_e L_t$	d	407	0.894*	39.96	1,10

a Ages 5-11
b Ages 3-15
c Ages 2-10
d Ages 3-17

* Significant at $P \geq 0.05$

mean length within each age class.

To determine growth rates, untransformed growth curves of walleye from Morfee and Lynx lakes (Fig. 15) and Ewart and Carr-Harris lakes (Fig. 16) were transformed according to the exponential model (Fig. 17). The linear equations describing the exponential model and the correlation coefficients for the regressions are summarized in Table 12.

As well as the exponential model the von Bertalanffy growth model was applied to walleye from Morfee and Ewart lakes (Fig. 18). Parameters for the von Bertalanffy model were determined from Walford plots (Fig. 13) and regressions of $\log_e (L_\infty - L_t)$ on t (Fig. 19). The equations describing the relationships of $\log_e (L_\infty - L_t)$ and t and the correlation coefficients of the regressions are summarized in Table 13. Higher correlation coefficients were obtained from the von Bertalanffy model for Morfee and Ewart lakes (-0.978 and -0.972 respectively) than from the exponential model (0.960 and 0.963 respectively).

The maturity data for walleye sampled from Morfee, Ewart, Lynx and Carr-Harris lakes is summarized in Table 14. The mean age of onset of sexual maturity ranged from 6.3 years in Lynx Lake to 9.3 years in Ewart Lake. The age at 100% maturity ranged from 7.0 years in Lynx Lake to 12.0 years in Ewart Lake.

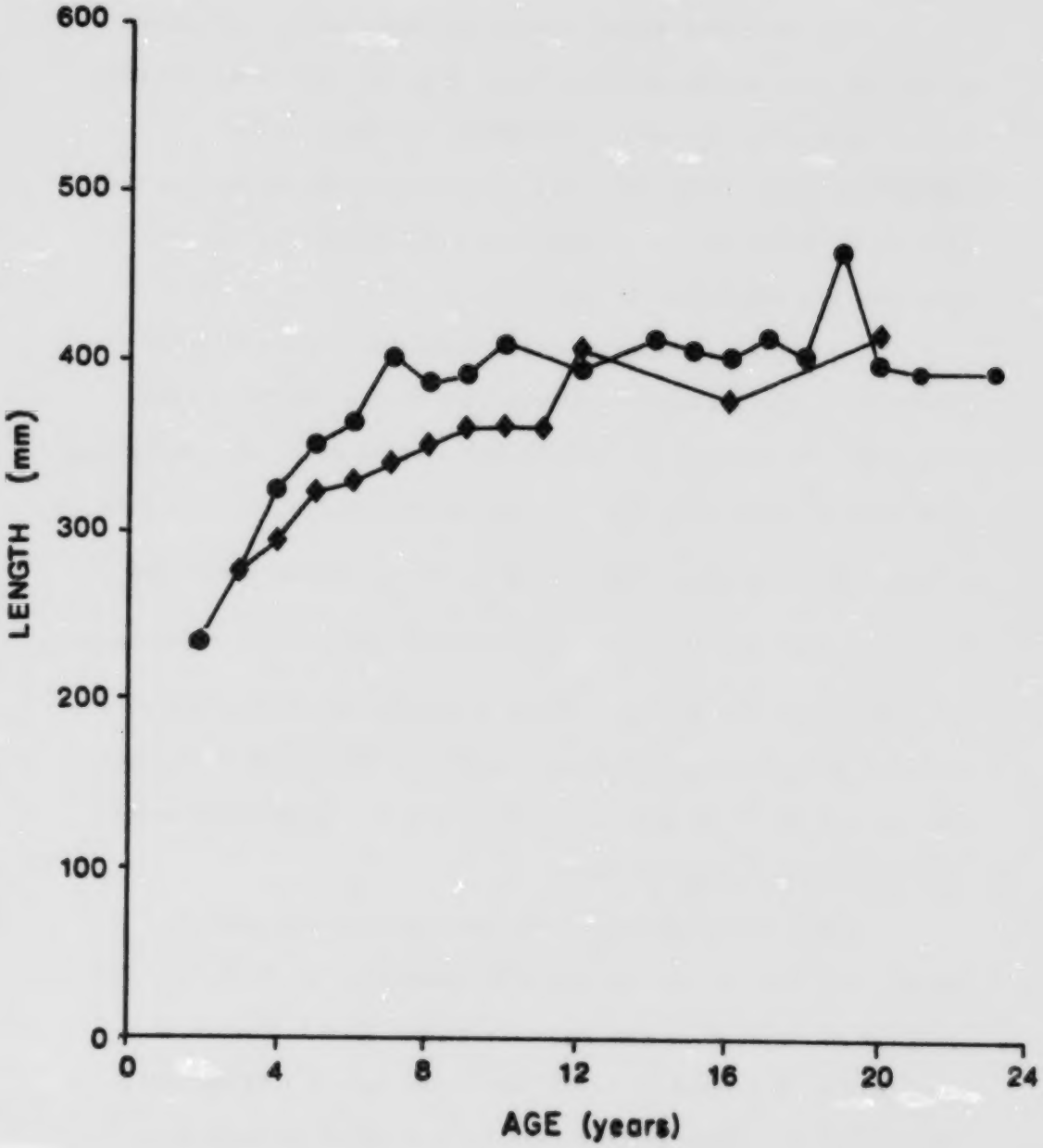


Fig. 15. Temporal changes in mean length of walleye from Morfee ◆ and Lynx ● lakes.

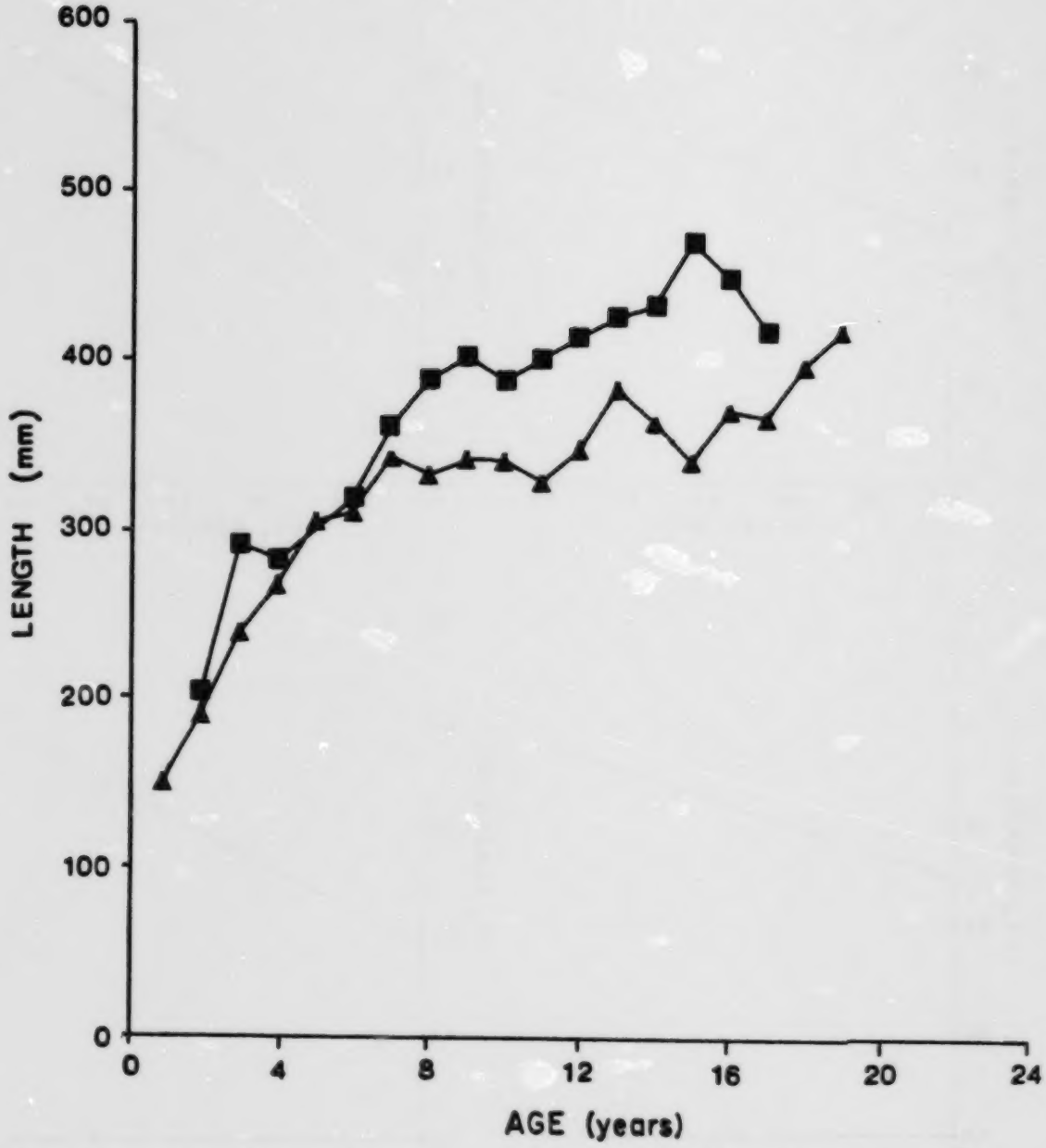


Fig. 16. Temporal changes in mean length of walleye from Ewart ■ and Carr-Harris ▲ lakes.

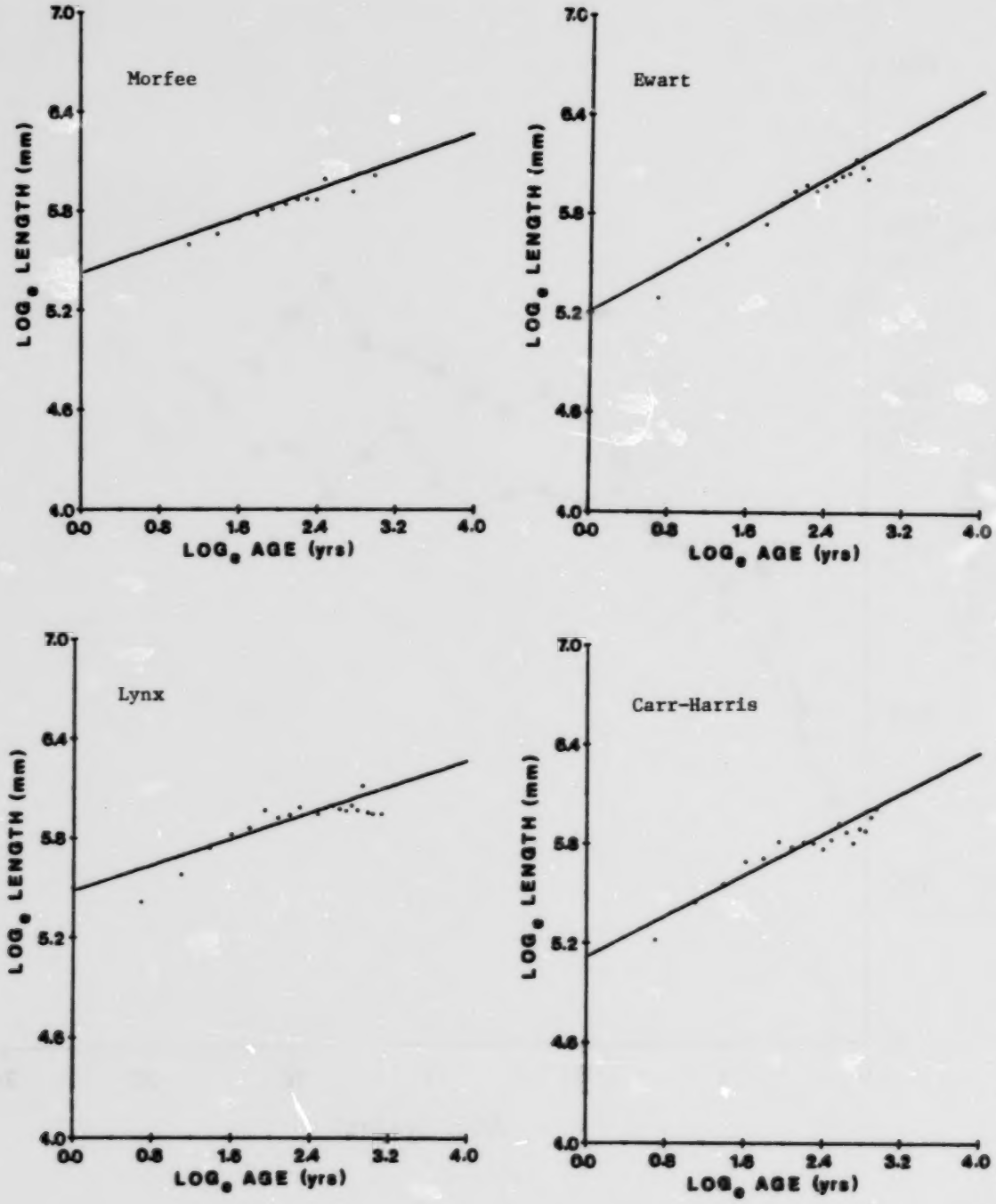
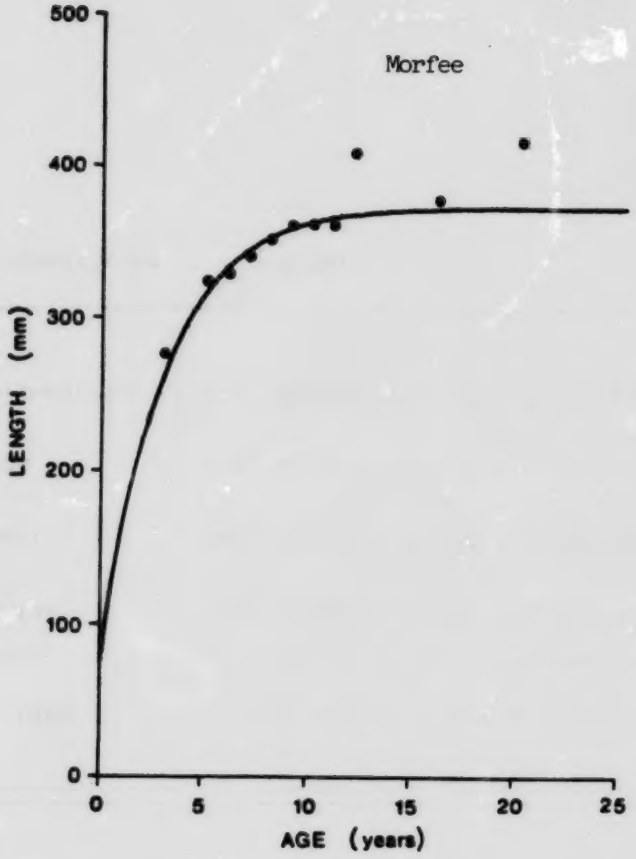


Fig. 17. Exponential growth curves of walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

Table 12. Exponential growth curves for walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

Lake	$\log_e$ length = a + b . $\log_e$ age	Age range (years)	Correlation Coefficient	Test F ratio and d.f.
Morfee	$\log_e$ length = 5.416 + 0.208 $\log_e$ age	3-20	0.960*	118.94(1,10)
Ewart	$\log_e$ length = 5.203 + 0.335 $\log_e$ age	2-17	0.963*	165.69(1,13)
Lynx	$\log_e$ length = 5.491 + 0.193 $\log_e$ age	2-23	0.861*	48.89(1,17)
Carr-Harris	$\log_e$ length = 5.124 + 0.305.$\log_e$ age	1-19	0.963*	217.02(1,17)

* Significant at $P \geq 0.05$.



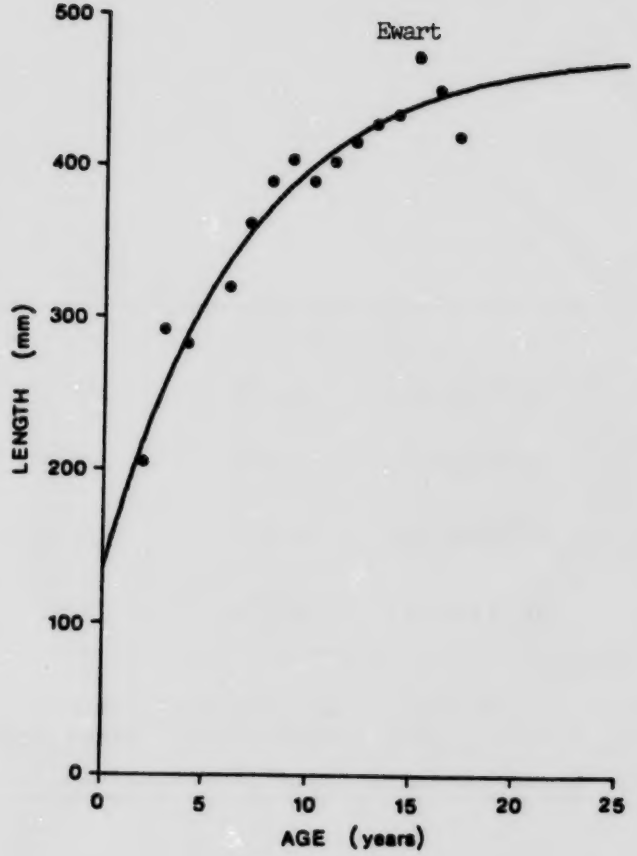


Fig. 18. von Bertalanffy growth curves for walleye from Morfee and Ewart lakes.

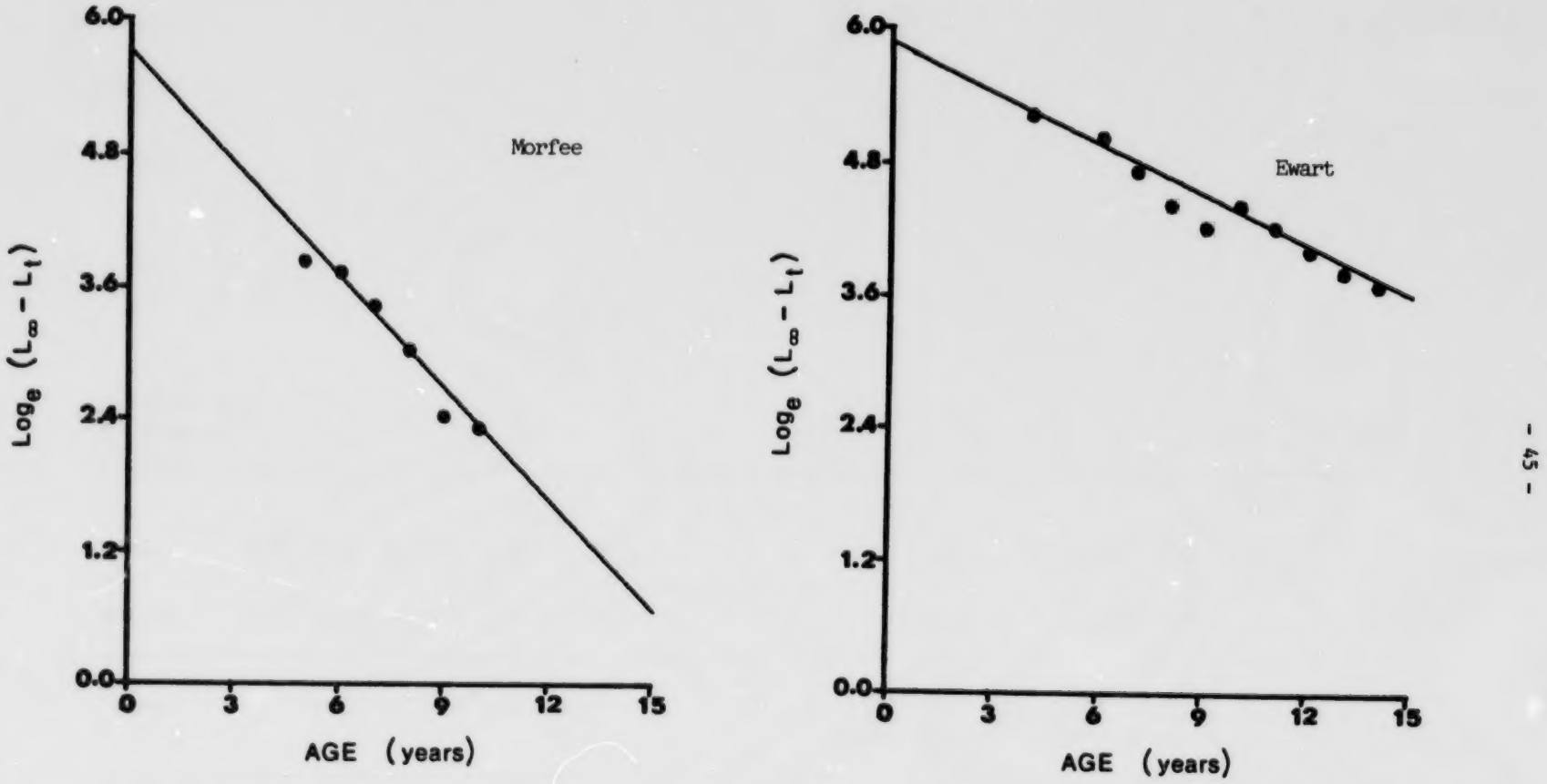


Fig. 19. Linear regressions of $L_\infty - L_t$ versus t for walleye from Morfee and Ewart lakes.

Table 13. Relationships of $\log_e (L_\infty - L_t)$ and t for walleye from Morfee and Ewart lakes.

Lake	$\log_e (L_\infty - 1_t) = a-bt$		Correlation Coefficient	Test F ratic and d.f.
Morfee	$\log_e$ (374-1t) = 5.729 - 0.337t	a	-0.978	87.57(1,4)
Ewart	$\log_e$ (479-1t) - 5.858 - 0.149t	b	-0.972	135.26(1,8)

a Ages 5-11
b Ages 3-15

Table 14. Maturity data for walleye from Morfee, Ewart, Lynx and Carr-Harris lakes.

	Morfee	Ewart	Lynx	Carr-Harris
Sex ratio (males to females)	1.04	1:1.68	1:2.00	1:0.97
Percent males mature	62.5	15.8	34.5	60.6
Mean length mature males (mm)	359	357	394	343
Percent females mature	68.0	71.9	55.2	65.6
Mean length mature females (mm)	362	434	411	363
Mean age at maturity (ẋ)	7.4	9.3	6.3	6.4
Age at 100 % maturity	8.0	12.0	7.0	9.0
Mean length at 100 % maturity	351	416	405	343
Mean age of sample	8.0	9.4	9.9	8.3

Northern Pike Age and Growth

The age-specific mean fork lengths, weights and condition factors for northern pike from Morfee, Ewart, Lynx and Carr-Harris lakes are presented in Table 15. The small sample size of northern pike from each lake does not permit an accurate representation of the age-frequency distributions (Appendix 5), length-age relationships (Appendix 6) or maturity regimes of the northern pike populations from these lakes.

Stomach Contents

The stomach contents analysis conducted on the walleye and northern pike sampled from the inventory lakes showed digested fish remains to be the most prevalent diet item. Of the identifiable remains, yellow perch were the most numerous (Table 16).

Production Potential

The morphometric and edaphic properties of the lakes were employed to provide an estimate of the maximum sustained yield (MSY) using the morphoedaphic index (MEI) by Ryder (1965). Derived potential yields are presented in Table 17.

It should be noted the mean depth for these lakes is less than the minimum for accurate application of the MEI method (Ryder et al., 1974). The fish production potential of these lakes should therefore be interpreted with caution. The MEI for all of the lakes falls in the eutrophic range (Adams and Olver

Table 15. Age-specific mean fork lengths, weights and condition factors for northern pike from Morfee, Ewart, Lynx and Carr-Harris lakes.

Age	MORFEE					EWART				
	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
1	-	-	-	-	-	1	14.29	260.00	100.00	0.57
2	3	16.67	348.00	283.33	0.67	1	14.29	360.00	200.00	0.43
3	2	11.11	394.00	385.00	0.63	1	14.29	452.00	640.00	0.69
4	2	11.11	483.00	690.00	0.62	1	14.29	560.00	1140.00	0.65
5	5	27.78	481.60	664.00	0.59	2	28.57	541.00	860.00	0.55
6	4	22.22	530.50	940.00	0.61	-	-	-	-	-
7	1	5.56	518.00	800.00	0.58	1	14.29	736.00	2180.00	0.55
8	-	-	-	-	-					
9	-	-	-	-	-					
10	1	5.56	590.00	1260.00	0.61					
11										
12										

cont'd.

Table 15 (cont'd.)

Age	LYNX					CARR-HARRIS				
	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
1	1	8.33	240.00	80.00	0.58	-	-	-	-	-
2	2	16.67	297.00	220.00	0.85	2	11.76	404.00	465.00	0.69
3	3	25.00	462.67	620.00	0.63	3	17.65	391.33	410.00	0.64
4	1	8.33	434.00	460.00	0.56	-	-	-	-	-
5	4	33.33	491.00	745.00	0.61	2	11.76	466.00	695.00	0.63
6	1	8.33	562.00	1240.00	0.70	4	23.53	540.00	1005.00	0.63
7						3	17.65	624.67	1913.33	0.67
8						-	-	-	-	-
9						-	-	-	-	-
10						2	11.76	867.00	3790.00	0.61
11						-	-	-	-	-
12						1	5.88	960.00	4500.00	0.51

Table 16. Stomach contents of walleye and northern pike from the inventory lakes.

	Morfee		Ewart		Lynx		Carr-Harris	
	Walleye %	N. Pike %	Walleye %	N. Pike %	Walleye %	N. Pike %	Walleye %	N. Pike %
Empty	24.2	64.7	3.8	85.7	2.1	83.4	36.8	88.2
Decapoda	-	17.6	-	-	-	-	2.6	5.9
Hirudinea	1.8	-	1.9	-	9.7	-	1.3	-
Ephemeroptera	-	-	-	-	-	-	5.4	-
Amphipoda	-	-	1.9	-	-	-	-	-
Odonata	3.6	-	5.6	-	-	-	-	-
Corixidae	-	-	-	-	1.1	-	2.6	-
Digested invertebrate remains	-	-	3.8	-	-	-	-	-
Yellow perch	27.9	11.8	13.2	-	55.9	8.3	14.5	-
Northern pike	-	-	-	-	1.1	-	1.3	-
Burbot	-	-	-	-	1.1	-	1.3	-
Trout-perch (Percopsis omiscomaycus)	-	-	-	-	-	-	1.3	-
Brook stickleback (Culaea inconstans)	1.8	-	-	-	-	-	-	-
Digested fish remains	40.7	5.9	69.8	14.3	29.0	8.3	32.9	5.9
No. of stomachs examined	53	18	53	7	87	12	70	17

1977). A more realistic determination of the trophic state of the lakes may be obtained by using the trophic state index (TSI) described by Carlson (1977). Based on a TSI of 0 - 100, it shows Morfee, Ewart, Lynn and Carr-Harris lakes to be mesotrophic (Table 18).

Table 17. MEI and estimated production potential (MSY) for Morfee, Ewart, Lynx and Carr-Harris lakes.

Lake	Mean depth (m)	TDS (mg/l)	MEI	Potential yield (kg/ha/yr)
Morfee	1.8	55.0	30.6	7.0
Ewart	1.9	61.0	32.1	7.2
Lynx	1.6	57.0	35.6	7.5
Carr-Harris	1.9	56.0	29.5	6.9

Table 18. Trophic state of Morfee, Ewart, Lynx and Carr-Harris lakes based on two parameters (Secchi disc and total phosphorus).

Lake	Secchi disc	TSI	Total Phosphorus mg/m^3	TSI
Morfee	1.4	55.1	20	47.4
Ewart	1.2	57.4	20	47.4
Lynx	1.1	58.6	30	53.2
Carr-Harris	1.2	57.4	20	47.4

DISCUSSION

Morphometry

The morphometry of Morfee, Ewart, Lynx and Carr-Harris lakes is typical of Precambrian Shield lakes. The shoreline of these lakes was predominantly rock with few sand beaches or flooded marshes. Sandy beach areas and shallow areas of rooted vegetation are important nursery and feeding areas for minnows and young-of-the-year yellow perch (Schupp 1978 and Clady and Nielson 1978). The absence of these habitat types may have an effect on the abundance of walleye in these lakes as prey abundance has been shown to have an effect on walleye recruitment and growth (Forney 1977). Yellow perch were found to be the preferred diet item of the walleye sampled from these lakes.

The absence of flooded marshes may be a factor regulating the abundance of yellow perch and northern pike. Yellow perch characteristically spawn over submerged vegetation and brush (Ney 1978) and northern pike characteristically spawn over flooded marsh vegetation and flat meadows covered by spring flood waters (Toner and Lawler 1969).

Johnson et al. (1977) have reported there is the possibility for greater success of walleye in small interconnected lakes in areas of flat relief, than in small lakes, poorly connected in areas of rugged relief. Morfee, Ewart, Lynx and Carr-Harris lakes are small lakes located on Precambrian drift of a rolling

to hilly nature, shallow and poorly connected.

The mean depths of the inventory lakes were less than 2.0m (Table 2). The Secchi transparencies for these lakes range from 1.1m in Lynx to 1.4m in Morfee. The average difference between the mean depth and the Secchi transparencies is 0.5m. This would be a factor in limiting the abundance of walleye in these lakes as walleye are negatively phototactic (Colby et al. 1979). In addition to the shallow mean depth and fairly high transparency the turbidity and colour of these lakes are also quite low (Table 3). This would limit the ability of the water to shield the eyes of the walleye from ambient daytime light intensities.

The shallow nature of these lakes would limit the amount of available winter habitat for the fish populations. In Morfee and Ewart lakes there are areas of deep water, but Lynx Lake has a maximum depth of only 2.0m and Carr-Harris Lake also is mostly 2.0m maximum depth. There would be very little winter habitat under approximately 1.0m of ice cover in Lynx and Carr-Harris lakes. It is likely that very low levels of dissolved oxygen occur during the ice cover period. It may be that winter dissolved oxygen levels are so low that partial winterkills may occur during severe winters in Lynx and Carr-Harris lakes.

Physical and Chemical Parameters

The temperature profiles recorded for Morfee, Ewart, Lynx and Carr-Harris lakes (Fig. 6) were very close to the lower limit of 20 C, the physiological optimum described by Hokanson (1977) for temperate mesotherm fishes. It would appear, therefore, that the reduced growing season of this area (June to September) would have a greater effect on the growth of the fish populations than summer extremes of water temperature.

The water chemistry data from Morfee, Ewart, Lynx and Carr-Harris lakes showed little spatial variation (Table 3). The values for specific conductance, total dissolved solids, nitrogen and phosphorus are very similar to other Precambrian lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980 and 1981). The ionic composition was also similar to that described by Armstrong and Schindler (1971) for dilute Canadian Shield lakes.

Fish

The age class structures of the walleye populations from Morfee, Ewart, Lynx and Carr-Harris lakes (Table 10 and Fig. 11) have a good distribution of older age, classes which indicates there has been no cropping of the older larger fish in the populations due to excessive angler pressure. Only Morfee Lake has a larger portion of younger age classes than older age classes. The remote nature of the lakes restricts access and it is unlikely

the age composition of Morfee Lake walleye is due to strong angler pressure. It more than likely reflects changes in year class strength caused by environmental factors which affect year class strength, such as water levels and changes in water temperature during incubation. The same is probably true for Lynx Lake walleye. The modal age was 5 years rather than 8+ years as the other lakes, due to the strength of the age 5 year class in Lynx Lake.

Comparison of the length-weight curves for walleye from these lakes indicates that at a given length the walleye from Ewart Lake would be heavier than those from Morfee Lake and the walleye from Lynx Lake would be heavier than the walleye from Carr-Harris lake at a given length. This is supported by the age-specific mean lengths and weights in Table 9.

The Walford estimates of asymptotic size appear to support the implied length-weight relationships. The L_∞ for Ewart Lake (479mm) is greater than the L_∞ estimate for Morfee Lake (374mm) and the L_∞ estimates for Lynx (407mm) is greater than Carr-Harris (351mm). Unfortunately the L_∞ estimate for Lynx and Carr-Harris are unrealistically low. In Lynx Lake 32.3% of the walleye sampled were longer than 407mm and 32.7% of the walleye sampled from Carr-Harris were longer than 351mm.

A comparison of the exponential growth curves of walleye from Morfee, Ewart, Lynx and Carr-Harris lakes to other lakes on the east side of Lake Winnipeg is presented in Table 19. It shows Ewart and Carr-Harris walleye growth is the same as Aikens and Harrop

Table 19. Comparison of exponential growth curves for walleye from lakes on the east side of Lake Winnipeg.

Lake	Slope exponential curve	Group	Comparison	F ratio and d.f.
Vickers	0.480)	1	Vickers - Dogskin	1.84(1,28)
Eardley	0.391)			
Dogskin	0.383)			
Ewart	0.335)	2	Ewart - Carr-Harris	0.76(1,30)
Aikens	0.329)			
Harrop	0.324)			
Carr-Harris	0.305)			
Family	0.299)	3	Family - Morfee	3.19(1,25)
Viking	0.258)			
Weaver	0.218)			
Morfee	0.208)			
Obukowin	0.201)	4	Obukowin - Wrong	4.42(1,31)
Lynx	0.193)			
Wrong	0.178)			

walleye growth. Morfee Lake walleye growth is the same as that of walleye from Family, Viking and Weaver lakes. Lynx Lake walleye growth is the same as Obukowin and Wrong lake walleye growth. It is apparent from comparison of the exponential growth curves that the Precambrian morphometry of the east side of Lake Winnipeg produces similar growth rates for the walleye inhabiting those lakes. The asymptotic size, however, varies a great deal from lake to lake.

The maturity regimes of the walleye sampled from Morfee, Ewart, Lynx and Carr-Harris lakes were similar to other east side Lake Winnipeg lakes (Hagenson and O'Connor 1981 and 1980). The calculated mean weighted ages of the onset of sexual maturity for the lakes were as follows: Morfee 7.4 years, Ewart 9.3 years, Lynx 6.3 years and Carr-Harris 6.4 years. Comparing these ages to Fig. 15 and 16 it is evident there is a decline in the growth rate approximating the calculated mean age of onset of sexual maturity. This conforms to the findings of Power (1978) who stated the growth of Arctic fish populations is relatively rapid until first maturity, when it becomes slow through a life span that may exceed 50 years. Mortality also declines rapidly through early life and stabilizes at a very low level through much of the life spawn. The age-frequencies (Fig. 11) for walleye from Morfee, Ewart, Lynx and Carr-Harris appear to conform to this hypothesis in that mortality is low beyond age 8+.

The small number of northern pike captured during the inventory of Morfee, Ewart, Lynx and Carr-Harris lakes does not

give an accurate representation of the populations growth or maturity characteristics. However, the age-specific means lengths of the northern pike sampled from Morfee, Ewart, Lynx and Carr-Harris lakes are similar to the age-specific mean lengths of northern pike populations from other lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980 and 1981). It is evident there is a great deal of variation in growth between different populations of northern pike (Toner and Lawler 1969) and (Franklin and Smith 1963). It has been reported by Toner and Lawler (1969) that the total mortality of northern pike populations is 50 to 85%. Even when fishing pressure is low, the total mortality appears to be about 50%. Franklin and Smith (1963) found there is no direct relationship between adult abundance and the strength of resulting year classes. Casselman (1978) has reported that northern pike are extremely tolerant of low winter oxygen and in shallow lakes where oxygen is greatly reduced during winter can readily survive minimum concentrations of 0.3 mg/1. Given these parameters it is likely there are sufficient northern pike in Morfee, Ewart, Lynx and Carr-Harris lakes to ensure moderate angler success for the species in these lakes.

A comparison of mean biomass per mesh from Morfee, Ewart, Lynx and Carr-Harris lakes to other lakes on the east side of Lake Winnipeg (Table 20) shows Vickers and Aikens lakes to be most comparable. Vickers Lake is located on the Pigeon River and is very similar in morphometry to Morfee, Ewart, Lynx and Carr-Harris lakes. (Hagenson

Table 20. Mean biomass per mesh from inventory lakes on the east side of Lake Winnipeg.

Lake	Mesh						Total
	1½	2	3	3-3/4	4¼	5	
Morfee	0.3	3.0	6.9	3.0	2.6	0.7	16.6
Ewart	3.0	2.1	2.5	3.9	2.8	0.4	14.7
Lynx	1.2	2.5	8.5	4.1	3.9	3.1	23.3
Carr-Harris	1.7	1.8	3.2	1.9	3.8	0.4	12.8
Harrop[1]	1.8	6.3	12.2	8.7	4.5	1.9	35.4
Eardley[1]	2.2	4.5	9.7	5.7	4.6	1.6	28.3
Weaver	3.7	7.3	16.8	11.4	10.5	3.4	53.1
Wrong[1]	1.8	6.3	15.9	9.7	9.8	5.3	48.9
Dogskin[2]	1.9	7.2	18.9	13.5	7.1	4.4	53.0
Family[2]	1.5	3.8	13.9	5.7	4.9	1.9	31.9
Viking[2]	2.8	4.8	9.1	7.7	5.0	1.8	31.3
Vickers[2]	0.9	1.2	6.8	4.4	2.6	0.7	16.6
Obukowin[3]	0.9	4.1	10.3	7.9	3.2	2.1	29.8
Aikens[3]	1.0	0.8	5.1	3.5	2.2	1.9	14.6

[1]Hagenson and O'Connor 1981

[2]Hagenson and O'Connor 1980

[3]Hagenson and O'Connor 1979

and O'Connor 1980). Even though it is on the Pigeon River it is fairly isolated to fish migration due to extensive rapids above and below Vickers Lake. The total biomass Vickers Lake can support is restricted to the basin of the lake itself. Aikens Lake is a classic oligotrophic lake on the Gammon River system (Hagenson and O'Connor 1979). A characteristic of an oligotrophic lake is a low biomass or standing crop (Ryder 1974). It is therefore, very probable that Morfee, Ewart, Lynx and Carr-Harris lakes, being unexploited, are at the climax state and are supporting the maximum biomass of fish flesh they are capable of. Morfee, Ewart, Lynx and Carr-Harris contain the main species components detailed by Ryder and Kerr (1978) for a harmonic percid community in the boreal forest zone, a characteristic of which is high community integrity resulting in stability of biomass. The netting results from these lakes showed percids to be the major component of the fish community comprising from 32.2% to 73.2% of the total yield in Morfee and Ewart lakes respectively.

A linear regression of MEI versus angling yield based on morphometric and creel census data from Nutimik, Caddy, White, Betula, Eleanor, Falcon, Brereton, Jessica and Lone Island lakes in the Whiteshell (Fig. 20) was used to provide an equation to estimate potential sustained angling yield from similar Precambrian lakes. The derived metric equation ($Y = 0.492\ X^{0.673}$) was applied to the morphoedaphic data from the inventory lakes and an estimate of

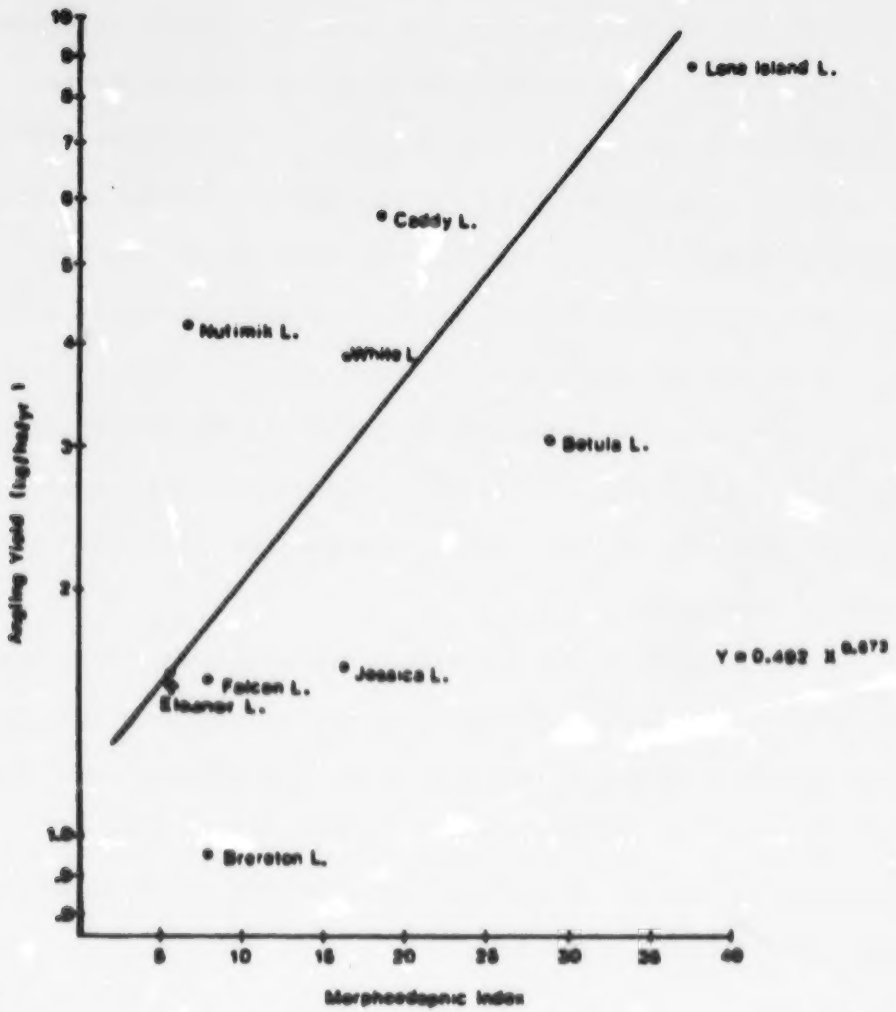


Fig. 20. Angling yield related to the morphoedaphic index for a relatively homogenous group of Precambrian lakes in the Whiteshell Provincial Park.

angling yield based on moderate quality fisheries were calculated (Table 21). Angling quality, total domestic, sport and commercial harvest and MSY calculations from Gods Lake were used to determine that no more than 15% of the MSY should be harvested to ensure a sustained high quality sport fishery (Hagenson and O'Connor 1978). The estimates of sustained yield for high quality angling are also summarized in Table 21. It should be stressed the MEI and MSY estimates calculated for Morfee, Ewart, Lynx and Carr-Harris are not precise figures because the mean depth of these lakes is less than the minimum for accurate application of the MEI method (Ryder et al 1974). Therefore, the estimates of potential angling yield also lack precision and are probably greater than these lakes are capable of supporting.

An examination of the Manitoba Master Angler Award records from 1972 to 1979 shows no awards for walleye or northern pike from Morfee, Ewart, Lynx and Carr-Harris lakes. The minimum qualifying weight is 3.6 kg for walleye and 9.0 kg for northern pike. It appears the walleye and northern pike populations of the inventory lakes offer no trophy potential.

Table 21. Estimates of potential angling yield for Morfee, Ewart, Lynx and Carr-Harris lakes.

LAKE	MEI	MSY	Estimated moderate quality angling yield kg/ha/yr	Estimated high quality angling yield kg/ha/yr
Morfee	30.6	7.0	4.9	1.0
Ewart	32.1	7.2	5.1	1.1
Lynx	35.6	7.5	5.4	1.1
Carr-Harris	29.5	6.9	4.8	1.0

MANAGEMENT IMPLICATIONS

Morfee, Ewart, Lynx and Carr-Harris lakes are small, headwater lakes on the Precambrian Shield and are low in productive capacity. The results of this inventory indicate they have a small standing crop of fish and are probably at their climax capacity. It is therefore, highly unlikely that a stock enhancement program such as stocking would improve the angling potential offered by these lakes.

The limited angling potential offered by the walleye and northern pike populations of these lakes make them unattractive as lodge lakes, assuming a 24 bed lodge would probably be required to be economically viable due to the remote nature of the lakes and the rising cost of aviation fuel. Even if the existing populations provided excellent angling, the limited base of the fish resource would lead to overexploitation. The low productivity of these lakes would make recovery from overfishing difficult as even light angler pressure would probably keep the remaining stocks at a depressed level. Such a situation would be most unacceptable to guests of a lodge.

The latest creel census data for the east side of Lake Winnipeg shows the average angler harvest per day to be 5.44 kg (Jardine and Sigurdson, 1981 and D. Fitzjohn Pers. Comm). It has been reported by SPOF Working Group No. 12 (1982) that the potential yield of a lake determined by Ryders morphoedaphic index may be partitioned into individual species yields (32% for walleye and 25%

for northern pike for sport fisheries). Therefore for a self sustaining moderate quality sport fishery no more than 57% of the MSY should be taken. The average occupancy rate for lodges on the east side of Lake Winnipeg over a 120 day season is approximately 45% (Carl Wall Pers. Comm). Combining this information into the following formula (J. O'Connor Pers. Comm) provides an estimate of the number of beds these lakes can support:

$$\text{No beds} = \frac{\text{MSY X .57 x Area}}{\text{H X S X O}}$$

Where H = harvest 5.44 kg
S = season 120 days
O = occupancy 45%

From the equation outcamps of the following size could be considered for these lakes.

Morfee	6 beds
Ewart	6 beds
Lynx	5 beds
Carr-Harris	14 beds

RECOMMENDATIONS

1. Morfee, Ewart, Lynx and Carr-Harris lakes should be considered only as remote outcamp lakes.
2. The number of beds per outcamp should not exceed the following recommended limits. Morfee 6, Ewart 6, Lynx 5 and Carr-Harris 14.

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MORFEE LAKE

Determined by P. M. Laufersweiler

Appendix 1. Plankton and benthos collected from Morfee Lake.

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanothece
Chroococcus
Gloeothece
Gloeotrichia
Gomphosphaeria naegliana
Lyngbya
Microcystis aeruginosa
M. (formerly *Aphanocapsa* spp)
M. wesenbergii
Oscillatoria
Pseudanabaena mucicola

CHLOROPHYTA (Green Algae)

Actinastrum
Botryococcus protuberans
Crucigenia rectangularis
Dictyosphaerium pulchellum
Gloeocystis
Mougeotia
Oocystis
Planctonema
Planktosphaeria
Scenedesmus
Spirogyra
Tetraedron limneticum
Ulothrix

Desmidiaceae

Arthrodesmus
Bambusina
Cosmarium
Pleurotaenium simplicissimum var. *simplicissimum*
Staurastrum
Staurodesmus extensus sp.
Teilingia
Xanthidium antilopaeum

CHRYSOPHYTA (Yellow-Brown Algae)

Dinobryon bavaricum
D. divergens
D. sertularia
D. tabellariae
Mallomonas
Synura adamsii

Bacillariophyceae (Preliminary analysis)

Anomoneis?
Asterionella
Caloneis
Cocconeis
Cyclotella
Cymbella
Diatoma
Diploneis
Fragilaria
Melosira
Navicula
Nitzschia
Rhizosolenia
Stauroneis
Surirella
Synedra
Tabellaria

PYRRHOPHYTA (Dinoflagellates)

Ceratium hirundinella
Gonyaulax?
Gymnodinium?
Glenodinium
Peridinium

PROTOZOA

Ciliatea

Epistylus

ROTIFERA

Asplanchna
Polyarthra
Keratella

ARTHROPODA

Crustacea

Branchiopoda

Cladocera

Bosmina
Chydoras
Diaphanosoma
Holopedium

Copepoda

Cyclops
Diaptomus

Mesocyclops edax?

Ostracoda

Insecta

Diptera

Chironomidae — Confirmed - B. Bilyj

Tanypodinae

Macropelopiini

Procladius

Pentaneurini

Ablabesmyia

Chironominae

Chironomini

Chironomus
Cryptochironomus (digitatus?)
Dicrotendipes
Glyptotendipes
Microtendipes
Polypedilum
Pseudochironomus

Tanytarsini

Stempellina
Tanytarsini sp.

Trichoptera (cases only)

EWART LAKE

Determined by P. M. Laufersweiler

Appendix 2. Plankton and benthos collected from Ewart Lake.

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanizomenon
Aphanothece
Chroococcus
Gloeocapsa
Gloeothece
Gloeotrichia
Gomphosphaeria lacustris
G. nageliana
Lyngbya
Merismopedia
Microcystis aeruginosa
M. (formerly *Aphanocapsa* spp.)
M. wesenbergii
Pseudanabaena mucicola
Synechocystis

CHLOROPHYTA (Green Algae)

Ankistrodesmus (formerly *Selenastrum* sp.)
Botryococcus protuberans
Coelastrum cambricum
Crucigenia rectangularis
Dactylococcopis
Dictyosphaerium cf *elegans*
D. pulchellum
Dimorphococcus
Eudorina
Monoraphidium
Mougeotia
Oocystis
Paulschulzia
Pediastrum araneosum
P. duplex
P. duplex var. *rotundatum*
P. kawraiska
Planctonema
Quadrigula
Scenedesmus
Spirogyra
Tetraedron limneticum
T. planctonicum
Ulothrix

Desmidiaceae	*Arthrodesmus*
	Closterium acerosum var.?
	Cosmarium
	Micrasterias crux-melitensis
	Penium?
	Pleurotaenium baculoides var. *baculoides*
	Spondylosium
	Staurastrum
	Staurodesmus mammilatus (var. *maximus?*)
	S. megacanthus var. *scoticus* fac. 3
	Teilingia
	Xanthidium antilopaeum
	X. subhastiferum
CHRYSOPHYTA (Yellow-Brown Algae)	
	Chrysosphaerella multispina
	Dinobryon bavaricum
	D. cylindricum
	D. divergens
	D. divergens var. *schauinslandii*
	D. sertularia
	D. tabellariae
	Mallomonas
	Ophiocytium capitatum
	Synura uvella
Bacillariophyceae	
	Asterionella
	Diatoma
	Frayilaria
	Melosira
	Navicula
	Nitzschia
	Rhizosolenia
	Surirella
	Tabellaria
PYRRHOPHYTA (Dinoflagellates)	*Ceratium hirundinella*
	Gymnodinium
PROTOZOA	
Ciliatea	
	Epistylus
ROTIFERA	
	Asplanchna
	Colletheca
	Keratella
	Polyarthra
	Trichocerca

ARTHROPODA

Crustacea

Branchiopoda

Cladocera

Acantholebris curvirostris
Bosmina
Chydoras
Diaphanosoma
Holopedium gibberum

Copepoda

Cyclops
Diaptomus

Malacostraca

Amphipoda

Hyalella azteca

Ostracoda

Insecta

Diptera

Chironomidae — Confirmed - B. Bilyj

Tanypodinae

Macropelopiini

Procladius

Chironominae

Chironomini

Chironomus

Trichoptera (cases only)

MOLLUSCA

Gastropoda

Pelecypoda

Sphaeriidae

CARR-HARRIS LAKE

Determined by P. M. Laufersweiler

Appendix 3. Plankton and benthos collected from Carr-Harris Lake.

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanizomenon
Chroococcus
Cylindrospermum?
Gloeothece
Gloeotrichia
Gomphosphaeria lacustris
G. naegliana
Lyngbya
Merismopedia
Microcystis aeruginosa
M. (formerly *Aphanocapsa* spp)
Nostoc
Oscillatoria

CHLOROPHYTA (Green Algae)

Ankistrodesmus (formerly *Selenastrum* sp)
Chlorella
Chlorococcus
Crucigenia crucifera
Dictyosphaerium pulchellum
Elakatothrix
Eudorina
Pediastrum boryanum
Paulschulzia?
Planctonema
Scenedesmus
Spirogyra?
Ulothrix

Desmidiaceae

Bambusina
Cosmarium
Staurastrum
Staurodesmus
Spondylosium
Teilingia

CHRYSOPHYTA (Yellow-Brown Algae)

Chrysosphaerella multispina
Dinobryon bavaricum
D. cylindricum var. *palustre*
D. divergens
D. sertularia

Mallomonas
Synura adamsii
S. uvella

Bacillariophyceae - Preliminary Analysis

Asterionella
Cyclotella
Diatoma
Entomoneis ornata
Fragilaria
Melosira
Navicula
Nitzchia
Stauroneis
Surirella
Tabellaria

PYRRHOPHYTA (Dinoflagellates)

Ceratium hirundinella
Gymnodinium

PROTOZOA

Rhizopodea

Difflugia?

ROTIFERA

Colletheca
Gastropus
Kellicottia
Keratella
Polyarthra
Trichocerca

ANNELIDA

Hirudinea

Oligochaeta

ARTHROPODA

Crustacea

Branchiopoda

Cladocera

Bosmina
Ceriodaphnia
Chydoras
Daphnia
Diaphanosoma
Holopedium
Leptodora
nr. *Ophryoxus gracilis*

Copepoda

Cyclops bicuspidatus thomasi
C. vernalis
Diaptomus

Ostracoda

Insecta

Diptera

Ceratopogonidae

Chaoboridae

Chaoborus

Chironomidae — Confirmed - B. Bilyj

Tanypodinae

Macropelopiini

Procladius

Coelotanypodini

Clinotanypus

Pentaneurini

Ablabesmyia?
Conchapelopia
Natarsia

Chironominae

Chironomini

Chironomus
Cladopelma
Cryptochironomus (digitatus?)
Dicrotendipes
Glyptotendipes

Tanytarsini

Stempellina
Tanytarsini sp.

Ephemeroptera

Hexagenia

Hemiptera

Corixidae

Trichoptera (cases only)

MOLLUSCA

Pelecypoda

Sphaeriidae

NEMATODA

LYNX LAKE

Determined by P. M. Laufersweiler

Appendix 4. Plankton and benthos collected from Lynx Lake.

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanothece
Chroococcus
Gloeotrichia
Gomphosphaeria lacustris
G. naegliana
Merismopedia elegans
Microcystis aeruginosa
M. (formerly *Aphanocapsa* spp)
M. wesenbergii
Oscillatoria

CHLOROPHYTA (Green Algae)

Ankistrodesmus (formerly *Selenastrum* sp)
Botryococcus protuberans
Crucigenia rectangularis
Dictyosphaerium ehrenbergianum
D. pulchellum
D. tetrachotomum?
Dimorphococcus
Eudorina
Mougeotia?
Pandorina?
Paulschulzia
Pediastrum araneosum var. *rugulosum*
P. boryanum var. *longicorne*
P. duplex
P. kawraiska
Quadrigula?
Ulothrix

Desmidiaceae

Arthrodesmus
Closterium
Cosmarium
Staurastrum
Staurodesmus glaber
S. nr. *mucronatus* var. *subtriangularis* fac. 4 and fac. 3
Teilingia
Xanthidium

CHRYSOPHYTA (Yellow-Brown Algae)

Chrysosphaerella multispina

Dinobryon divergens
D. sertularia
D. tabellariae?

Bacillariophyceae - Preliminary Analysis

Asterionella
Fragilaria
Melosira
Navicula
Rhizosolenia
Stephanodiscus
Synedra
Tabellaria

PYRRHOPHYTA (Dinoflagellates)

Ceratium hirundinella

ROTIFERA

Asplanchna
Colletheca
Gastropus?
Kellicottia
Keratella
Trichocerca

ANNELIDA

Hirudinea — Determined by R. W. Davies

Placobdella sp

ARTHROPODA

Crustacea

Branchiopoda

Cladocera

Bosmina
Diaphanosoma
Daphnia retrocurvata
Holopedium

Copepoda

Cyclops
Diaptomus
Mesocyclops edax?

Malacostraca

Amphipoda

Hyalella azteca

Ostracoda

Insecta

Diptera

Chaoboridae

Chaoborus

Chironomidae — Confirmed - B. Bilyj

Tanypodinae

Macropelopiini

Procladius

Chironominae

Chironomini

Chironomus
Glyptotendipes
Polypedilum

Trichoptera (cases only)

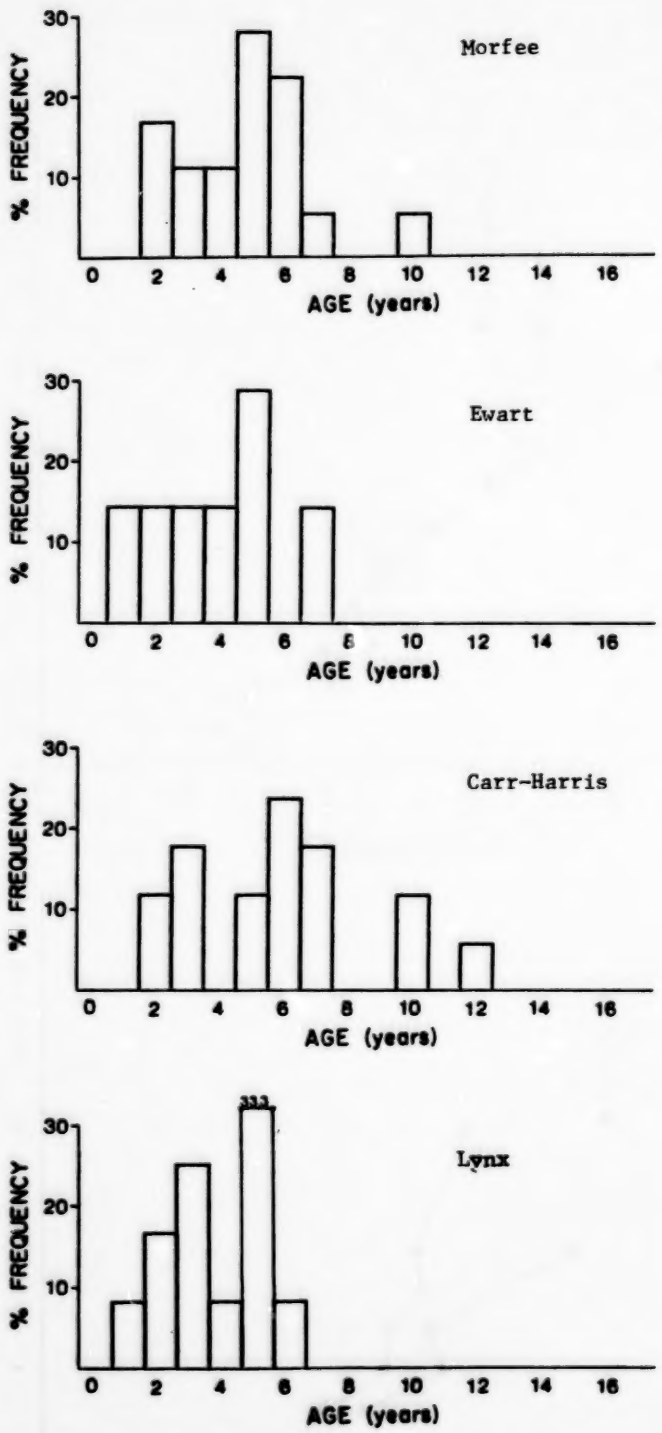
MOLLUSCA

Pelecypoda

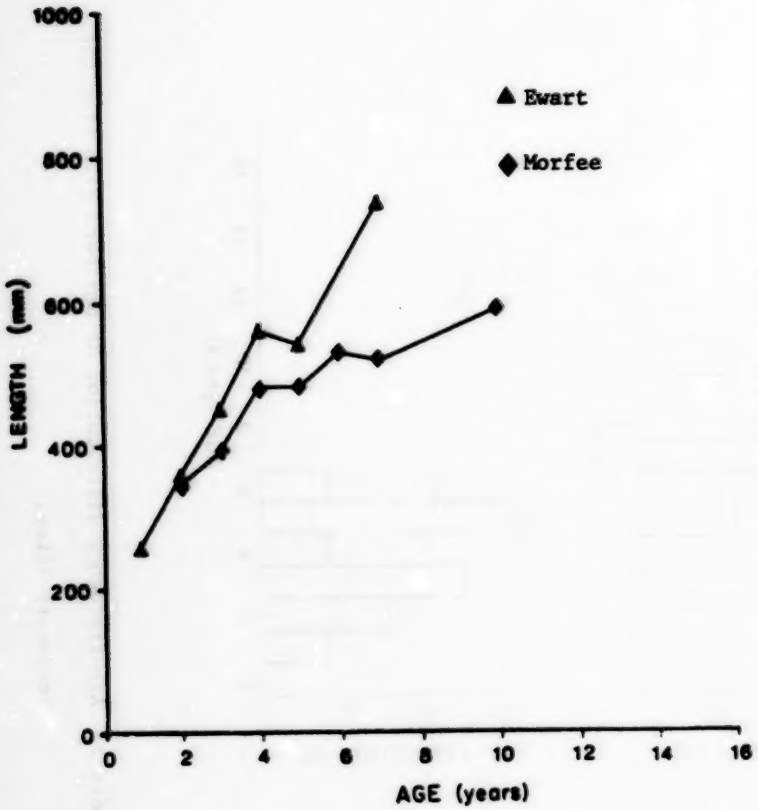
Sphaeriidae

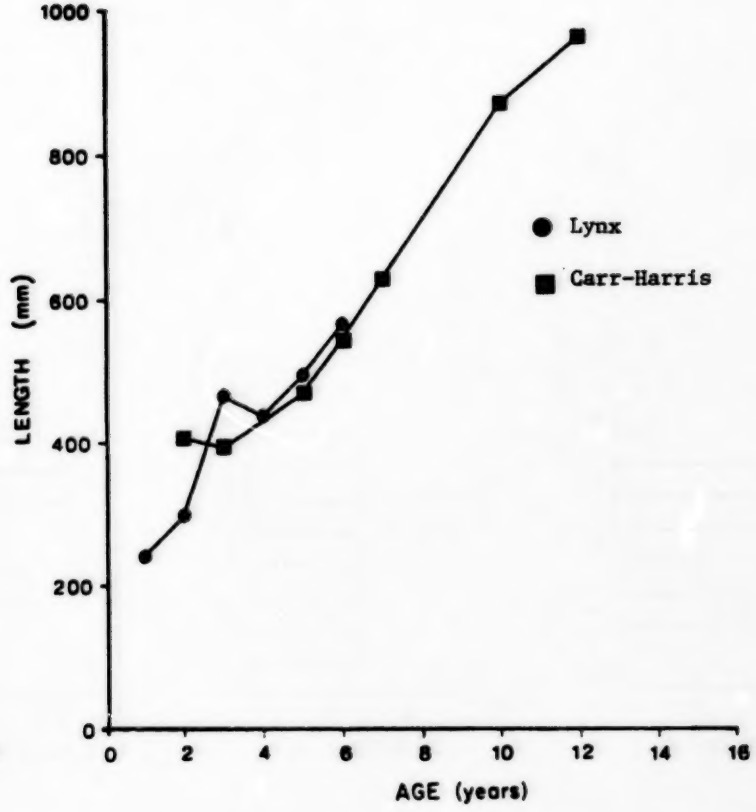
Pisidium casertanum

Sphaeriidae sp.



Appendix 5. Age-frequency distribution of northern pike from the inventory lakes.





Appendix 6. Temporal changes in mean length of northern pike from the inventory lakes.